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NOVEMBER, 1905

VOL. IV. NO. III.

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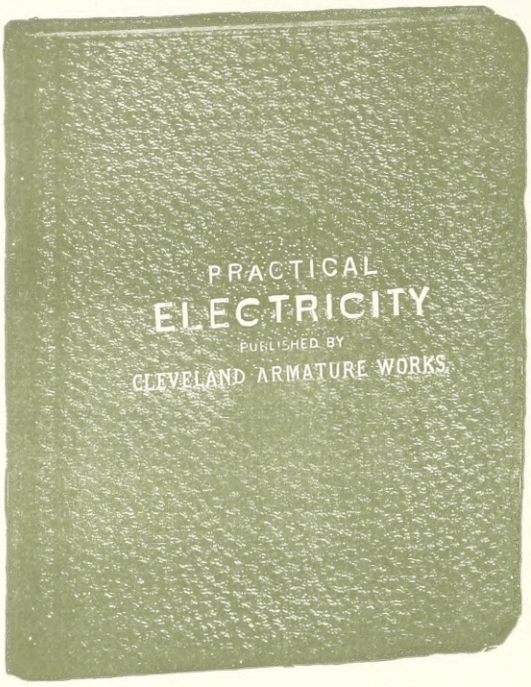

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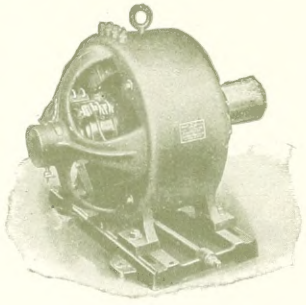

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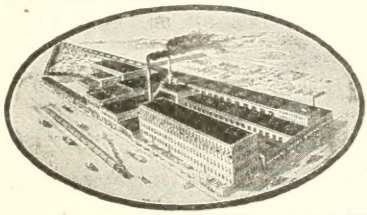

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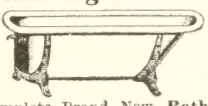

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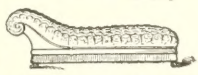

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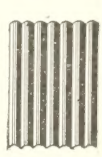

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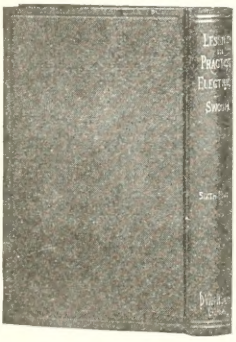

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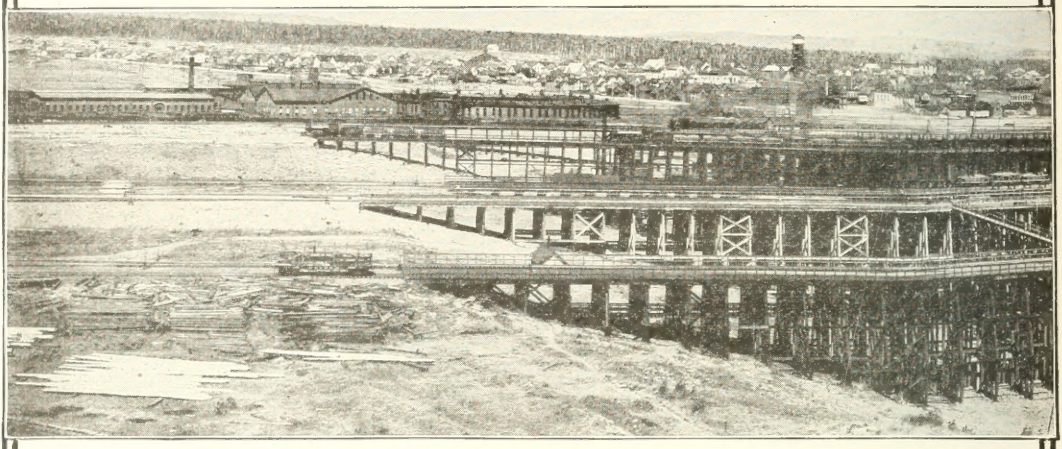

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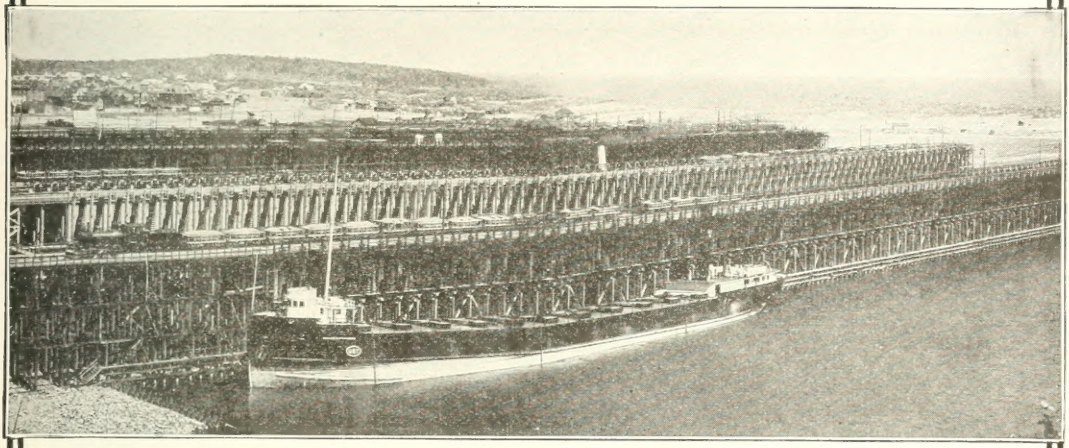

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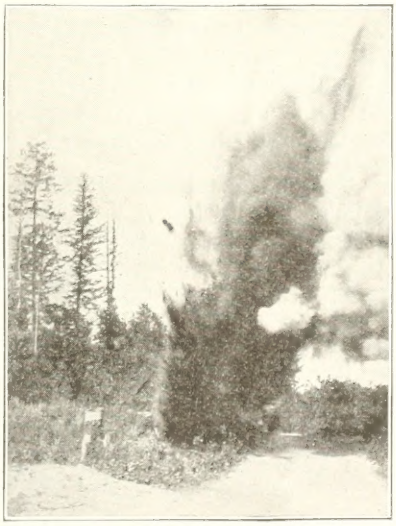

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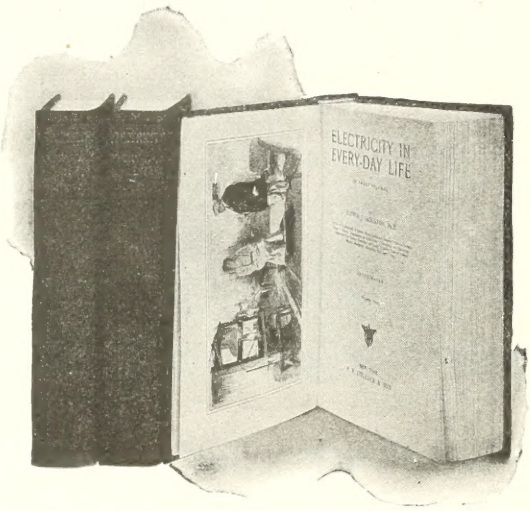

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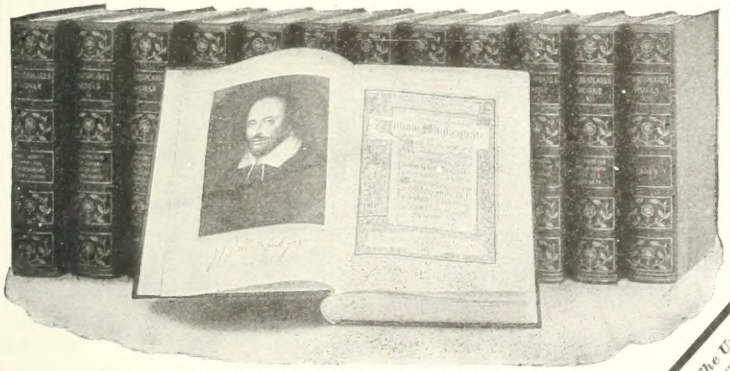

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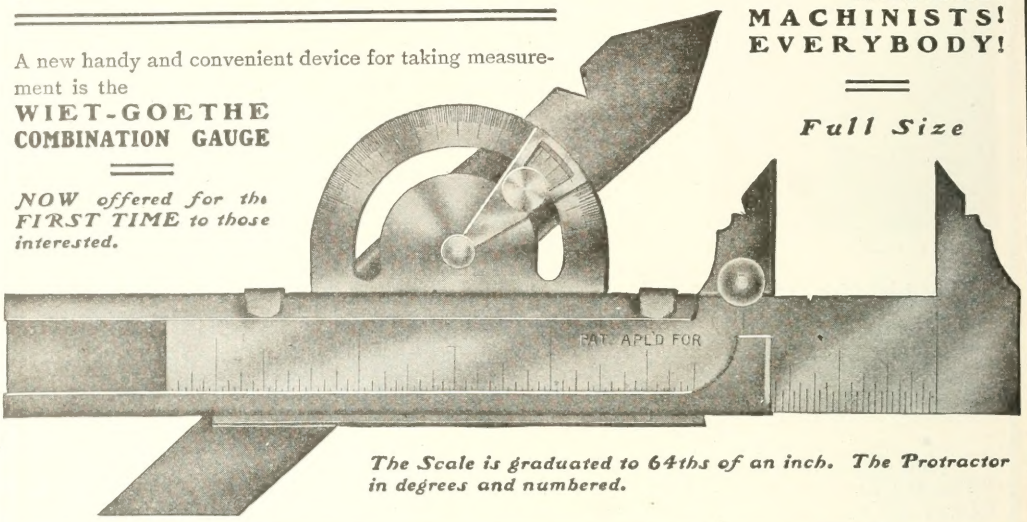

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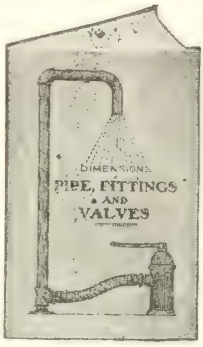

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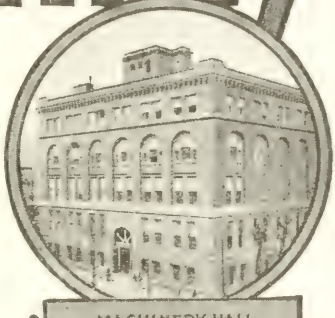

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(See page 341)

The Technical
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Volume IV NOVEMBER, 1905 No 3

Saving Ocean Liners

Thrilling and Profitable Work of the Great Salvage Companies

By P. T. McGRATH

Staff Correspondent of THE TECHNICAL WORLD MAGAZINE, St. John's, Newfoundland

WHAT the insurance patrol is to the fire department of a great city, what the wrecking train is to a railroad, the great salvage companies are to the steamship lines of the world.

Let a steamboat or other craft of any value strike a rock or run upon a reef along almost any coast, and, before the life-saving service has completed its work, the great ocean-going tugs of one of these salvage companies may be already rushing across leagues of stormy water with the purpose of making the money loss occasioned by the accident as small as possible.

Every year on the coast of the British Islands alone an average of five thousand ships are wrecked. The total value of ships and their cargoes thus endangered is upwards of $50,000,000. The annual total imperiled on the ocean and fresh water shores of the United States will almost duplicate this great sum. It is plain, therefore, that from a monetary standpoint the business of the salvage companies is a most important one. And there is no work which requires more splendid daring, more instant decision, and more resourceful ingenuity than that of the salvage engineer.

England and United States Behind

Both England and the United States are the headquarters of several important and widely known salvage companies, but the greatest of them all in the perfection of their appliances and in the scope of their operations are German and Dutch corporations.

Time is vastly important in all salvage operations. The wise ship-owner, once his vessel has gone upon the rocks, wastes no time in haggling over the price to be paid for its safe rescue. He knows that within an hour a storm may rise and pound his ship to pieces. There are just enough examples of the result of such hesitation to keep the lesson perfectly clear and plain. Thus, for instance, when in 1902 the Elder-Dempster liner *Assyrian* grounded on the rocks at Cape Race, Newfoundland, known to mariners the world over as the "ocean graveyard," the agents of the line at Quebec stopped long enough to debate prices with several firms of salvors. At the end of a week they had succeeded in cutting down the

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estimate for saving the *Assyrian* almost one-half; but unfortunately, when the contract was finally let and the tugs went out to do the work, the poor steamship was no longer there. Ship and cargo valued together at half a million dollars had gone down in the night and were a total loss.

Aground upon a Rock-Bound Coast.

Depends upon the Weather

So the salvage engineer is more dependent than almost any other man upon the condition of the weather for the success of his work. When in July, 1899, the American liner *Paris* struck the Manacle Rocks in the English Channel and drove a sharp piece of flint through her bottom, two salvage companies unsuccessfully attempted the task of dislodging her, and, had it not been for the perfectly fair and calm weather which continuously prevailed, the third attempt must also have failed.

The necessary equipment for a ship salvage company is complicated and costly. First there must be a fleet of ocean-going tugs, grim, square-built, bulldogs of the sea, able to take a long voyage without risks and also to stand up under the dead weight of a sodden hull, to which they may be attached. Their engines must be enormously heavy, so that they may exert power enough to lift half the weight of an ocean liner from a ledge of rock or to work centrifugal pumps at a rate fast enough to keep a hull free of water, once it is afloat, until the rents in its bottom can be temporarily repaired.

Pumps and Cranes and Coffer Dams

With the tugs must go spacious floats, fitted with cranes and other lifting appliances; lighters to which the cargo may be removed from wrecked ships; coffer-dams and pontoons, by the use of which sunken ships may be lifted from considerable depths; pumps with the capacity of a thousand tons of sea water an hour; air bags, which are used to lift small craft. And, of course, most important of all, is a staff of fearless and competent divers, directed by a salvage engineer, who is ready for any sudden emergency and is not afraid to take chances, even when wind and water are playing the other hands in this greatest of gambling games.

Most salvage contracts are made on the basis of "no cure, no pay," so that, in-

stead of making a large sum, a salvage engineer may find himself, at the end of a week's hard work, facing, instead, a tremendous loss. On the other hand, as happened when, in June, 1905, the big new Allan liner *Hibernian* struck the rocks near Cape Race, Newfoundland, and a New York salvage firm sent its equipment 900 miles to the scene of the accident, he may make a fee of $100,000 for a few weeks' work.

SALVAGE TUG.

Notable Salvage Work

Could a complete record be made of the most important salvage feats of recent years they would challenge the imaginings of a practiced romancer. One of the really amazing instances was that of the steamer *Milwaukee,* which in September, 1898, while on a voyage from Newcastle-on-Tyne to New Orleans, went ashore near Aberdeen, a large rock penetrating the bottom of her fore-hold to a height of eight feet above her tank-top, making it impossible to get her off entire. But as she was afloat from the main bulkhead aft, dynamite was employed to cut her in two pieces and save the after-part, which contained her machinery. Small cartridges of dynamite were fixed to the hull along a line or belt round her bottom forward of the bulkhead; and by a series of explosions during a period of ten days

STEAMER *SCOTTISH KING* ASHORE ON THE NEWFOUNDLAND COAST.

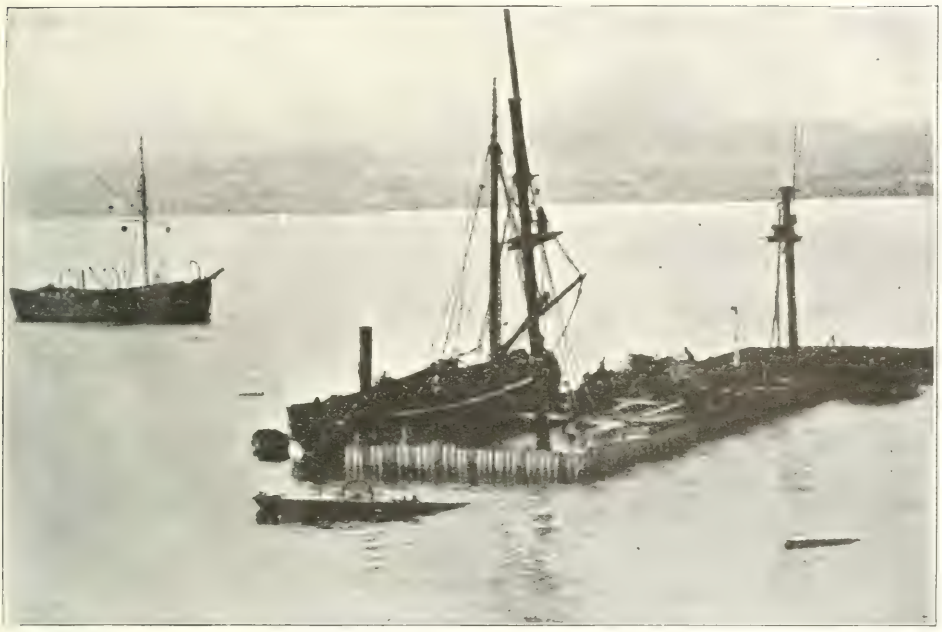
and utilizing 500 pounds of dynamite, the hull was cut in two. The job was a most delicate one, the charge requiring to be powerful enough to rend her plates asunder without injuring her bulkhead, for if that happened the remainder of the ship would also have to be abandoned. But such a mischance was fortunately avoided, and this strange craft set afloat on the ocean. Then another difficulty supervened, the weight of the machinery, at one end, uplifting the stern so that she was virtually unmanageable, and increasing the pressure on the bulkhead.

Saving Half a Ship

This was overcome by flooding the stern-hold till she reached an even keel again, when she was towed back 150 miles to Newcastle—the bare tail end of a ship—without the bulwarks weakening. There she was docked and a new forepart built onto her, so that when finished she measured only six tons less than when originally launched.

Scarcely less extraordinary was the case of the *Utopia*, a big Italian emigrant steamer bound from Genoa to New York with 1,000 passengers, which during a heavy gale in Gibraltar Bay, in June, 1893, drifted down on the ram bow of the British battleship *Anson* and impaled herself thereon, a fatal gash being made in her side, which caused her to careen and sink almost instantly, carrying 200 persons down with her to an ocean grave. She lay in shallow water, almost in the fairway, with her funnel and masts showing above the waves, and her location such a serious obstacle to the safe navigation of the port that the authorities ordered her immediate salvage or destruction. An examination of her hull and position suggested that her recovery was possible, though her stern was 57 feet below the surface and she had a list to port, while swift and variable currents also formed a serious obstacle to success in the undertaking. A huge cofferdam was built upon the hull, practically extending it upward from the deck to the sea level, and requiring to be enormously strong to withstand the pressure of waves, tides, and currents. Indeed, this structure is held by competent authorities to have been a marvel of engineering skill of its kind, as the difficulties which had to be

THE *MILWAUKEE*, CUT IN TWO BY DYNAMITE.



BUILDING A COFFERDAM AROUND THE SUBMERGED SHIP *KOTTINGHAM.*

met in erecting it were exceptional, and it employed an army of divers for weeks.

Raised from Fifty-Seven Feet

When it was built, the divers patched with timber and cement the hole in the ship's side which had sunk her, and then the water in her hull was pumped out by the tremendously powerful pumps which are specially contrived for this kind of work. Within an hour after they began, they lightened her so that she was lifted off the bottom; and as she rose she was towed closer to the shore until at last she was beached. Then the rent was patched with steel plates, the cofferdam dismantled, the hull pumped dry, and she refloated, being towed to Glasgow for permanent repairs, the whole of the salvage work being done within three months.

Another example of the use of a specially constructed cofferdam was the case of the steamship *Kottingham,* which sank off Jarrow, England, obstructing the channel seriously. The accompanying photograph illustrates the nature of the contrivance used to raise her. The water enclosed within the hull and the walls of this cofferdam being pumped out, she gradually rose, and being drawn towards the shore as she did so, was successfully beached and repaired.

Cofferdam a Favorite Device

Scores of ships have been "salved" by British concerns by this method, which is much in vogue for salvage operations in European waters. A novel development of the cofferdam principle was employed in one case recently, that of the steamer *Fernside,* which, during a mid-winter storm, struck on a ledge near Tonsberg, Norway, and her forepart sank. The deck was shored in the different holds, the hatches and apertures were tightened so as not to leak, and an attempt was made to pump her dry; but the deck could not bear the pressure of the water above it, and other means had to be resorted to. Iron cofferdams were constructed and fitted to her shape, being then fixed to her sides and made watertight. The work was frequently interrupted by storms and high seas, the iron constructions being several times destroyed, for the task was being performed amid the tempests of winter on the Norwegian coast; but it was persisted in by the salvors until success crowned their

efforts and they towed her to a safe anchorage.

Boosting off a Ship

An ingenious expedient was devised some years ago to refloat the steamer *Flavian,* which struck on a ledge near Cape Race. She was fixed in an awkward position for tugs to work at her, and half her hull was submerged. It was in the late fall, and proper salvage outfits could neither be obtained from abroad in time nor used advantageously. So a series of holes were cut in her sides, below the 'tween decks, and huge pitch-pine logs passed through these apertures. Meanwhile two cofferdams, 60 feet long by 12 wide and as many deep, had been built at St. John's and, after being carefully calked, were towed to the scene and allowed to sink by opening a valve, being then placed beneath the logs which passed through the ship and protruded on each side. The water in the cofferdams was next pumped out, and as they rose they caught the logs and fairly lifted the ship off the rocks, she being towed to St. John's with them upbearing her till permanent repairs could be made, which involved patching her bottom for half her length.

Saving a Cable Steamer

Another noteworthy case occurring in Newfoundland waters was the wreck of the French cable steamer *Pouyer-Guertier,* in December, 1898, at St. Pierre-Miquelon. She drove on the rocks in a blizzard, scarred her underbody severely, broke off her twin screws and both shafts, and threatened to become a total wreck. Salvors from St. John's undertook to refloat her, and after great difficulty succeeded in doing so. The weather was terrible and the water of arctic frigidity, so that the divers who were patching the rents in her bottom with timbers and cement suffered intensely. Powerful steam-pumps were then used to free her holds, and the resulting buoyancy enabled her to float off at the next high tide. But this was almost the least of the troubles, for she was altogether helpless, made considerable water even with the pumps working at their full capacity, and, if she met a storm while *en route* to St. John's,

STEAMER *FLAVIAN* BERTHED AT ST. JOHN'S, NEWFOUNDLAND.

must certainly have sunk. Though the distance is but 130 miles, it took 25 days for her to be towed there, as she and the steamer which towed her had to skirt the shore and harbor at the first evidence of bad weather. When she was docked, 150 new plates had to be inserted in her under-body, and the salvage and repairs cost $105,000.

Wreck of the "Oregon"

From Newfoundland to Japan is a far cry, but there is a close parallel between the foregoing salvage case and that of the American battleship *Oregon,* which, when on the China station in June, 1900, drifted on a ledge of uncharted rocks while heaving up her anchor after riding a night in the Howki Channel, partly submerging her bow. A salvage operator working on a Japanese freighter some distance away, learned of the battleship's plight, hurried to the scene with his pumps, and arranged to help in salving her. The damaged hull was repaired by divers, then the pumps were set agoing, and within three days she was afloat again. But within half an hour she struck another reef, and more heavily, being put in a worse plight than before, as she was lifted three feet out of her displacement. She was lightened by taking out her coal and ammunition, the divers made good her fresh damage, the pumps were once more set to work, and five days later she was again afloat, having come off the rocks herself when sufficiently lightened by the ejection of the water within her hull. She proceeded to the dry-dock at Kure and effected repairs.

STEAMER *FERNMOR* ASHORE ON THE NORWEGIAN COAST.

Lifted by the Tide

A novel process of recovering a wreck was that employed in the case of the lightship *Puffin,* of Queenstown, which foundered during a gale. Two barges were moored on each side of her at low tide, with stout cables passed under her bottom and fastened to the barges, so that as the tide rose the wreck was lifted and towed inshore till it grounded again. The cables being tautened at the next low

tide, the performance was repeated, and renewed until she was ultimately beached. A still more remarkable instance of this was the case of the steamer *Firefly,* which went ashore on the Newfoundland coast some years ago, and, being hauled off again by tugs, was found to have her bottom and sides so severely strained that the pumps could not keep her free and she threatened to founder. Several schooners were hastily hired and moored to her sides; chains and cables were brought from one to another under her bottom; and, securely fastened to these craft, and thus supported, she was towed of two winters. Her salving was a costly and protracted job, efforts being first made to blast away the rocks which held her, then to free her by means of pumps, then to patch her bottom and get her afloat; and lastly the expedient was adopted of securely sealing the hatches and other openings, strengthening the decks by cross-beams, and forcing compressed air into the holds, so that the hull was made buoyant enough to slide out over the reef again into deep water. On the cushion of air which supported her and defied the inrush of water through the gashes in her bottom, she

STEAMER *FIREFLY* IN ST. JOHN'S HARBOR, UPHELD BY A FLEET OF SCHOONERS.

to St. John's for dockage and repairs, the accompanying photograph showing her and her flotilla at anchor there.

Raised by Compressed Air

A striking instance of the employment of compressed air as an auxiliary to the floating of a wreck was that of the steamer *Scottish King,* which went ashore on the Newfoundland coast and lay there intact for nearly eighteen months before she was got off. She had struck a reef and gone in over it, rasping off the greater portion of her bottom, lying then in a natural harbor, so to speak, being thereby enabled to withstand the storms was floated and towed to St. John's, where she received a new bottom. The whole work cost about $60,000, and she did not bring within $10,000 of that when completed and sold.

Pulled out of the Mud

A still more extraordinary case was the steamship *Wick Boy,* which sank at King's Lynn, England, and for four years baffled all attempts to raise her. She was embedded in 30 feet of mud and only partially visible at low tide. Several salvage concerns endeavored to raise her, but failed, though at length the work was successfully accomplished. Some 3,000

RAISING THE STEAMER *UTOPIA*.

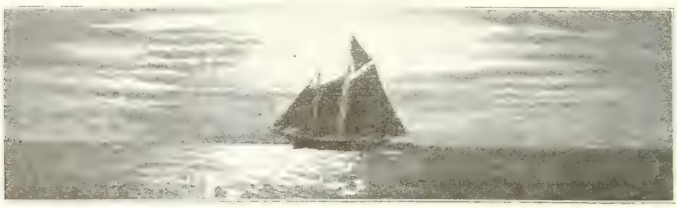
tons of mud were first pumped out of the wreck, divers manipulating the suction pipes inside the vessel. Then a large caisson was constructed by them in the engine room, the decks were strengthened and the hatches sealed. The water being next pumped out, the ship rose from its oozy bed and was towed away on its broadside till it reached a harbor, where temporary repairs were made so as to get it on an even keel and into dock, that it might be permanently restored.

Salvage Not Always Profitable

Not every salvage job is successful, or yields a profit even if it is carried out. In the early months of 1897 the British ship *Glenmorag* went ashore on the Pacific coast and after great effort was got off by the local wrecking concerns, swinging safely into deep water. But in trying to get an anchor clear which had fouled, she drifted back on the beach again, in a worse position than before. Capt. Wm. Burns, a famous English salvage expert, who had previously refloated 135 vessels without a single failure, was despatched by Lloyd's to the scene, and tried to save her, spending in the fruitless endeavor some $30,000, which would have built a larger and finer vessel. It was the one failure in his career. The ship *Kilbrannan* was another case of an unprofitable salvage job. She struck in

WRECKED STEAMER AND SALVAGE TUGS.

the Strait of Fuca and was on the rocks for more than a month, being then hauled off by six tugs after her hull had been patched. The entire work cost $12,000, and when sold she fetched but one-third of that sum. The *Azalea*, which stranded in Belle Isle Strait, was a third case of this kind. Salvors were at work on her for six months and their outlay was about $17,000, while, when repaired and put up for sale again, she realized for her owners but $6,500.



A Song of Street Labor

THEY are working beneath the sun,
In its red-hot, blinding glare,
In the dust from the toiling teams,
In the noise of the thoroughfare.
See them swing and bend, far down to the end,
With the rhythm of the strokes they bear.

The cords of the sinewy arms
Stand out like the cable's twist;
No blow shall miss and no stroke shall fail
From the grasp of the brawny fist,
As the shoulder swings when the pickaxe rings
And the hand springs firm from the wrist.

Let the feet of the dainty-shod
Pass by on the other side,
Where the youth of the slender back and limb
Stands watching—the listless-eyed,
While with sweat and with pain and the long day's strain
These toil—and are satisfied.

—CAROLINE A. LORD,
in American Illustrated Magazine.

Fifty-Four Miles of Book Shelves

How More than One Million Books Are Handled in the Congressional Library at Washington

By C. H. CLAUDY

Formerly Editor, *The American Inventor*

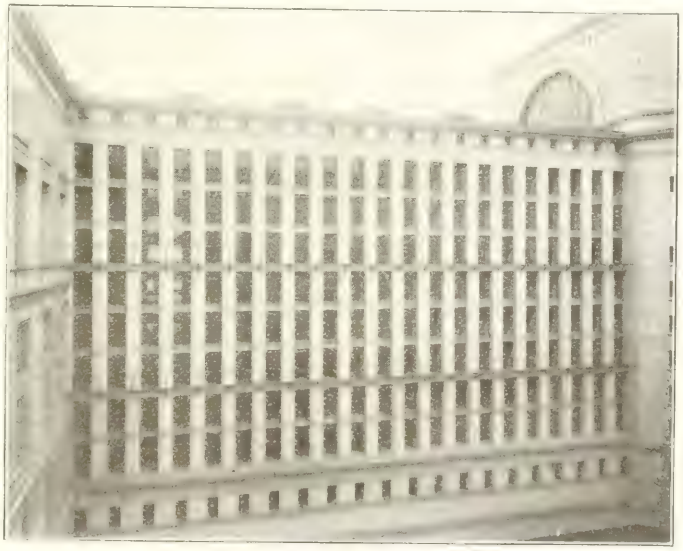
IN architectural beauty, in the splendor of its interior decorations, the Congressional Library at Washington ranks with the first great public buildings of the world. But not less impressive and wonderful, if less conspicuous, is the machinery by which the more than a million books on its fifty-four miles of shelves are transported and handled.

As the illustration shows, the library building is rectangular in shape, with a central tower, from which run four internal wings. Three of these wings are filled with book stacks; the fourth is the entrance rotunda. Two of the book stacks are very large, each containing twenty-six miles of shelving. The third, at the back of the building, is much smaller, and, as it is not connected with the machinery, is not to be particularly considered here.

Views of the Book Stacks

Two of the illustrations show the exterior of the book stacks, and the interior of one of the decks in a stack, of which there are nine. The interior view, of course, shows only the cases on one side of the aisle running down the center of the deck—there are an equal number on the other side. Two such stacks, containing nine decks, or floors, each, and having altogether fifty-four miles of shelving, make room for more than one million books. Also, they occupy considerable space; and to send a messenger after any one book, would take a good deal of time, and a large force of messengers, if the public were to be accommodated.

When the reader enters the central reading room, he proceeds to the central desk to get his book. He writes out on a slip of paper, supplied him for the purpose, the name of the book and the name of the author, and hands it to an attendant, after adding the number of the reading desk he has selected. In a surprisingly short time the attendant lays the book before him.



BOOK STACK IN CONGRESSIONAL LIBRARY

Nine floors, 26 miles of shelves. Connects with rotunda on right and building on left. All windows are permanently kept closed, on account of dampness. The floors are all open grated, each book case and ventilation is secured by forced air from basement.

How a Book is Secured

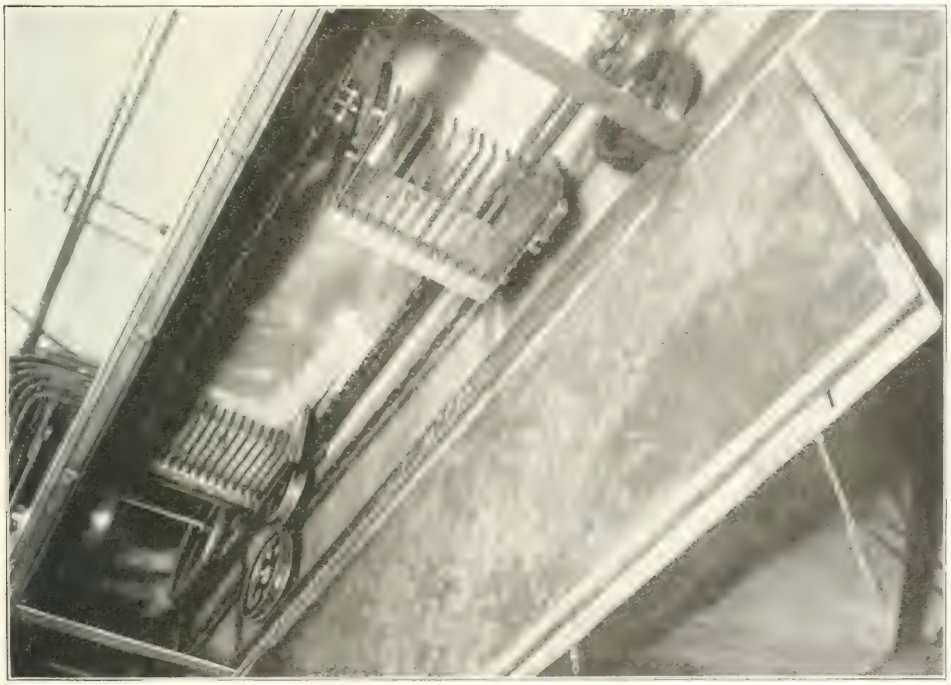
What has happened is this. The slip of paper has been put into a small closed cylinder, which, in turn, has been slipped into a pneumatic tube connected with the

LIBRARY OF CONGRESS, WASHINGTON, D. C.

The Library Building is a hollow square, with dome in center and bookstacks and entrance hall radiating from center to sides. The dome is coated with solid gold.

particular desk of the stack on which the book called for is to be found. At the same time a button is pressed which calls the attention of the attendant on duty on that deck to the fact that an order slip has been sent him. The pneumatic tube delivers the little cylinder almost instantly, the attendant reads the slip and finds the book called for. He takes the book and places it on a grating at the edge of a chute and presses a lever. Immediately a book carrier, which is within the chute, picks the book from the grating, carries it to the bottom of the stack, under the building, and thence up into the center of the reading room, where it is picked from the carrier by another grating and slides off into a padded receptacle, from which an attendant takes it and gives it to the reader. When the reader is through with the book and turns it in at the desk, the attendant puts it on a grating, turns a knob until a pointer marks the number of the deck to which it is to go, when a car-

INTERIOR OF DECK IN A BOOK STACK.
Note openings in floor and ceiling for ventilation.



LOOKING UP INTO OPEN IRON CONDUIT FOR BOOK-TRANSFER MACHINERY.
Note upright position of book casket and its hand-like construction.

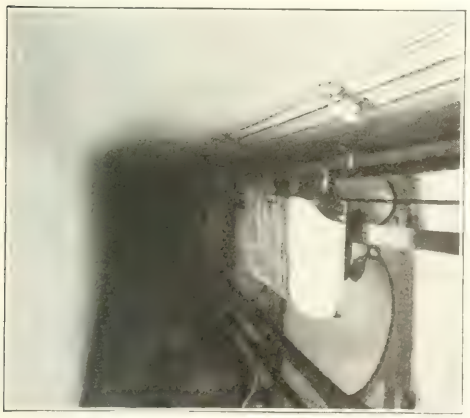
MAIN READING ROOM, U. S. CONGRESSIONAL LIBRARY.

In the center of the central circular desk is the housing for the book-handling machinery. Card catalogue in foreground. View facing entrance.

rier seizes it and takes it to the proper deck and there deposits it, for the attendant to put away.

Describes the Machinery

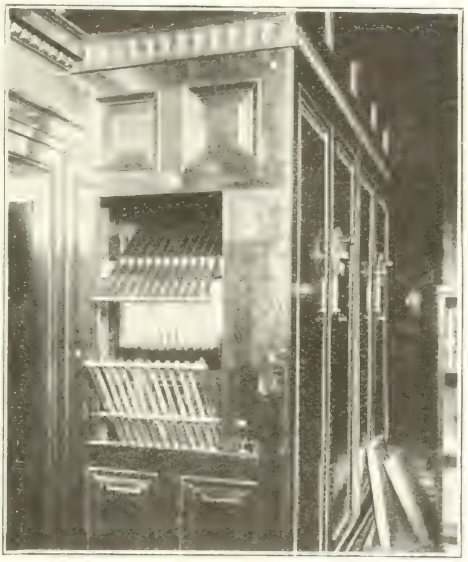
This apparently marvelous device is in reality very simple, and so is very effective. The book-carrier system consists of two parallel endless sprocket chains, twenty and one-half inches apart, which are driven all day, without stopping, by an electric motor, at the rate of one hundred feet per minute. These chains run over sheaves arranged so that the book trays which they carry may pass over the sheaves without difficulty. The chains run from the sheaves in the reading room, down to the cellar, then horizontally to the bottom of the book stack, then vertically up the center to the top of the stack, through all nine decks, from which they return by a parallel course to the reading room. There are eighteen book trays on each carrier system (there are two systems, one for each stack). These trays are made of aluminum, brass, and iron, and are constructed something like a large hand, with outspread fingers, turned up. The tray bottoms consist of a horizontal set of parallel brass fingers. This comb-like construction is made to



TUNNEL FROM LIBRARY TO CAPITOL.
Length, 1,275 feet. Contains book trolley, pneumatic tubes, and telephone and electric light wires.

pass through other stationary combs which thus remove the contents of the carrier. These combs, or toothed racks, are located at the stations on the stack decks, and at the terminal in the reading room.

On the back of each tray are ten keys, the positions of which are altered by striking projections governed by the handle and dial referred to in the reading room terminal, and seen in the illustra-



RECEIVING AND SENDING STATION IN CENTER OF READING ROOM, FOR BOOKS.
Note handles and dials on side of case, by which carrier caskets are made automatically to go to the right place.

tion of that place. Nine of these keys correspond to the nine decks in the stack, —the tenth is a general key which permits the carrier to pass when not in use.

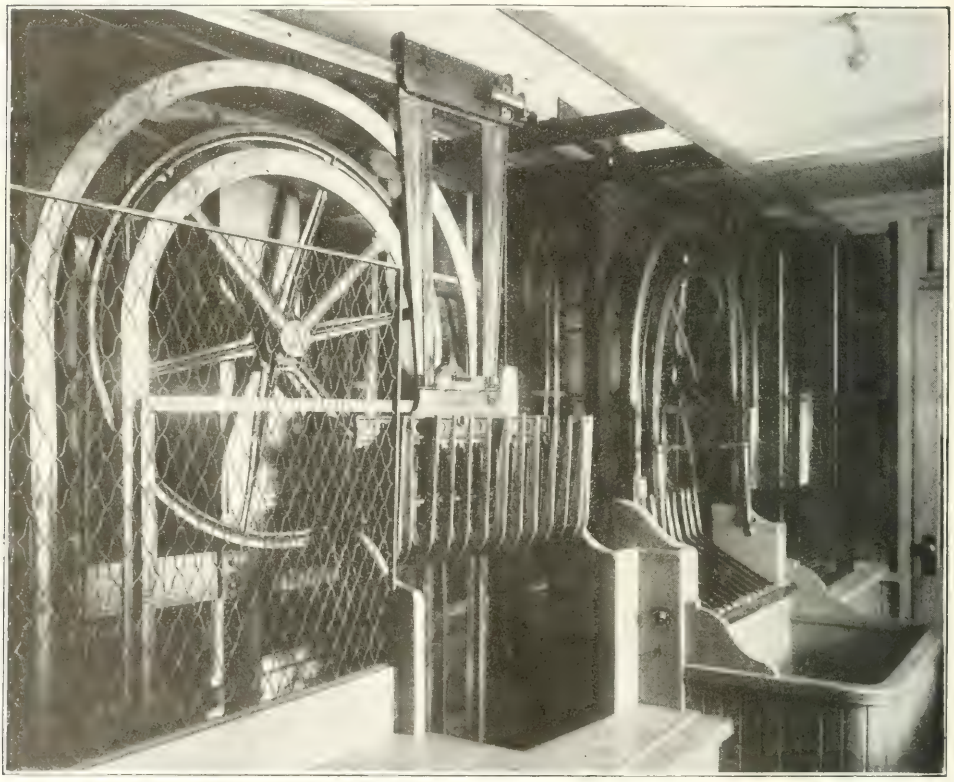
How the Carriers are Emptied

When the dial in the reading room is set, however, we will say to number five, the next book carrier to pass is automatically set, key number five being erected and all the others put out of commission. This carrier will now continue its way until it reaches deck number five, when the key will engage a pawl, which will bring inwards a tooth rack that will comb off the contents of the carrier. At the same time, the fifth key is depressed, and the general key, which allows the carrier to pass all stations, is erected.

In the illustration of the reading room terminal, the box, with the padded spring bottom, has been removed in order to show the receiving and delivering combs. The upper comb is the one which removes books from the descending carrier; the lower one is the one which places

books in the carrier. Two handles and dials are plainly seen on the side, which regulate the two systems for the two stacks, as already described.

In one of the illustrations devoted to that part of the system, the carriers and chains are shown, photographed overhead in the cellar, the iron conduit having been opened for the purpose. The photograph gives a very good idea of the construction of the carriers and of the manner in which they remain horizontal regardless of the angle taken by the chains which bear them.



LIBRARY TERMINUS OF THE INTER-BUILDING TROLLEY.
Note receiving comb and box, and size of sheaves over which cable runs. This machinery is directly beneath center of Reading Room, and is reached by stairway from inside central desk.

Tunnel to the Capitol

It will be remembered that this library is the Congressional Library—that is, it is first for the use of Congress. It used to be located in the Capitol, and when a Member, Senator, or Supreme Court Judge wanted a book, he sent a page after it. Now the library is nearly a quarter of a mile in a direct line, and more than that as one has to walk, from the Capitol building. Obviously, to keep a force of messengers running from building to building with books and messages would be both cumbersome, expensive, and slow. Instead of that, a tunnel connects the two buildings, and a trolley line runs between them, on which is a book carrier and in which books are shipped as they are called for.

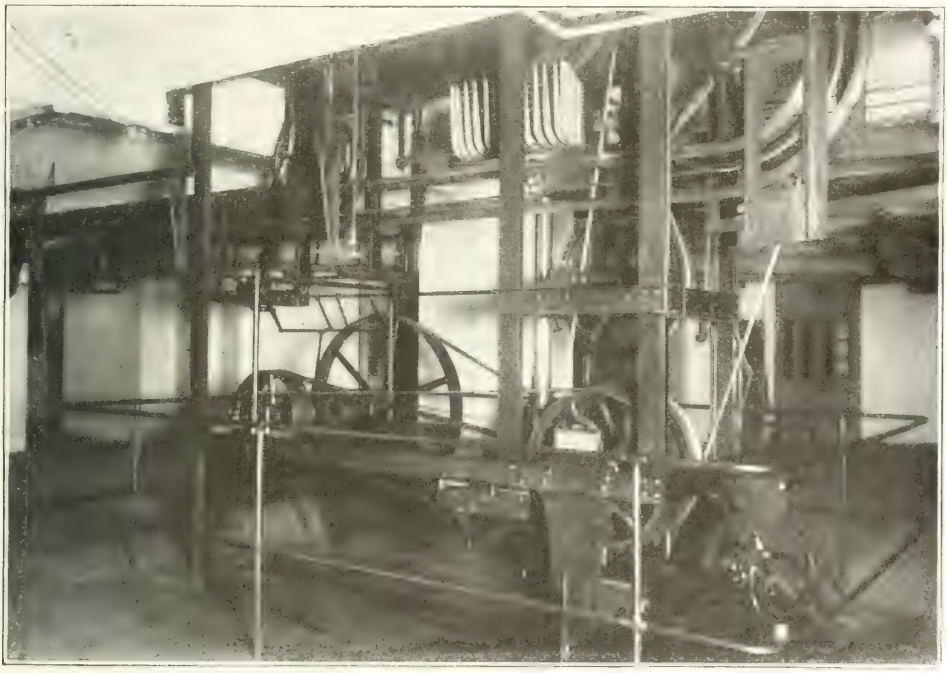
When a Member or Senator wants a book, he causes the name to be written on a card which is sent to the library by pneumatic tube. It is received at the central desk in the reading room, and the attendant procures the book exactly as he would for the casual reader. It is then carried by hand down a short flight of stairs from the central desk, and put in the receiving comb for the Capitol. When the Capitol carrier comes along, it picks it out of this comb in the same way that

the smaller carriers do in the library book-transfer system.

Large Carriers for Capitol

In the Library-to-Capitol carrier system the carriers are much larger—sufficient in size to contain a bound volume of newspapers, while the regular library carrier is not supposed to handle books larger than an ordinary encyclopedia. If the book to go to the Capitol is small, it is put in a leather pouch made for the purpose, which is handled like a book. The cable is of metal rope and endless. It runs through the tunnel for a distance of 1,275 feet. In the illustration of the library terminal are seen the large sheaves over which the cable passes. On the first down trip, over the first sheave, the car discharges its contents, and it picks up the new contents on its second up trip, over the second sheave. The removing comb and receiving box are plainly visible in the illustration. The apparatus does not run constantly, but is started by pressing a button from the library side. It can be both started and stopped from the library but stopped only at the Capitol. The cars ride at a speed of six hundred feet a minute, so that very little time is required to send a book between the buildings.

The tunnel is not quite large enough for the average man to stand upright in; it was dug from the surface and, while *straight,* is not *level,* following the curves of the surface at an average distance of about ten feet from the top. The digging of the new Washington Union Station tunnel, which passes between the Capitol and Library buildings, has caused this tunnel to sink a little in some places but not enough to do any appreciable damage.



MOTOR AND DRIVING MACHINERY FOR TROLLEY LINE BETWEEN LIBRARY AND CAPITOL.
Located in basement of Library Building.

The other two illustrations show the driving machinery at the library end, and the tunnel itself, with a carrier on the way. The tunnel carries, besides the trolley line, the pneumatic tube line, telephone line, and electric light wires for lighting the tunnel.

The entire system, the invention of Superintendent Green of the library, is unique.

"Loafin' Round" with the Engineers

Strenuous Day's Work of Capt. Nicholas Ivanovitch, of the Russian Army, During the War in Manchuria

By RICHARD HENRY LITTLE

War Correspondent

RICHARD HENRY LITTLE was war correspondent for the *Chicago Tribune* during the Spanish-American war and in the Philippines. He went out to the Russo-Japanese war representing the *Chicago Daily News*, arriving in Tokio two days before the declaration of war. After a month in Japan, went to Korea and then to Chefoo, where he took charge of the newspaper dispatch boat *Fawan*, in which he cruised around Port Arthur and the Shan-Tung peninsula until captured at sea by the Russians and taken into Newchwang. After being released, applied for and received permission to join the Russian army in the field, with which he remained almost a year and until captured with the Russian rear guard while on its retreat to Tieling after the battle of Moukden. Witnessed the battles of Tashichiau, Anping, Ansanjan, Liao Yang, Sha Ho, Sanjapu, and Moukden. After capture by the Japanese, was taken with the other prisoners to Shidzioka, where he was interned in the Russian prisoners' quarters until paroled and sent to America.

CAPTAIN NICHOLAS IVANOVITCH was so indignant that he spluttered like a cat while he tried to voice his feelings.

"Ah! ha! So they did tell you that we, the engineers, did not any work. And who was it said this? Ah, tell me this very night. I will him to the death fight, that the honor of the gallant corps of the engineers may thus be veendeecated. His name, my friend, tell me the name of this the scoundrel-l."

I didn't want to be a talebearer. I dodged the issue and said that it was only information I was after, that I merely had repeated a derogatory remark concerning the gallant engineers in the hopes of hearing the engineers' side.

Captain Demands Blood

"But," said the captain, still bristling like the fretful porcupine, "this insu-ult I can not pass by. 'Twas that pig of a Peter of the infantry. Ah ha, and can one of that despised branch say mockings to the engineers? Ah ha! And what did the infantry at Wafenggo, at Daschichau, at Liao Yang? They tarried not even in the beautiful entrenchments that we, the engineers, did make for them. Ah such entrenchments, so high, so thick with the wire entanglements in the front, the wolf traps also and the mines. To me shall Peter, he of the skulking infantry, answer."

The captain was girding on his sword. Peter of the infantry was fast getting into trouble. I interposed. "It was not Peter."

Cossacks are Threatened

"Not. No. Ah!" The captain sat down and poured out a liberal dose of vodka. "It is very well. His life I spare. Then 'twas that dog Vladimir of those thieving Cossacks. Ah, and does one of that service dare speak of the engineers? Cossacks, they who have done of the nothing whatsoever; who have disappointed all. Of nothing have they success. They in all things have failed. But still must that Vladimir fight the duel."

"No, no," I said hastily. I liked Vladimir, and besides he owed me ten rubles. I did not wish to see him die. "'Twas not Vladimir."

The captain tried to think up some one in the artillery that would be likely to fling open insults at the engineers. This was not hard. The artillery is prone to grossly libel the gallant sappers. He ran over twenty names in as many seconds. I denied them all. Finally he gave up in despair and sorrowfully unbuckled his sword.

Engineers Always Slandered

"Ah, my friend, 'tis the fashion," he said, "for these, the artillery, the infantry, and the gentlemen who ride around on horses, to say the bad words of the engineers. And yet 'tis we who do the work, the fight, the vigil, the everything, but they understand not. Always they point at us the finger, and make the sorry face, and utter the laugh of mocking."

The captain started in on a ringing defense of the noble engineers, but there was so much to say that he could not talk fast enough in English, and finally he stopped short in despair. Then a smile lit his face.

"Ah, my friend, it is best that you go out with us and see for yourself. This night, in an hour, we start. We have much to do. There are new roads to lay out, a bridge or two to build, but you shall see. Come and find for yourself whether or not we, the engineers, are of the worthiness to wear His Majesty's uniform. Come."

Wolf Traps for Japanese

I was ready to admit by noon of the next day that the engineers worked hard, but I did not find their life wildly exciting. Wolf traps become in time extremely monotonous. That was our work. For the uninitiated it might be well to explain that these wolf traps were not intended for wolves but for the Yellow Peril, a few of whom watched us cautiously from a hill afar off and now and then sent a bullet whizzing down to us as a gentle reminder that they were going back pretty soon to tell Oyama just what we were up to. We didn't care just how soon they went, and as they seemed to be indifferent about it themselves, a half company of sappers went out and chased them away.

"You see," said the captain, as the rattling sound of the Russian rifles came

SIXTH PONTOON BATTALION OF THE RUSSIAN ENGINEERS.
On the way to the front.

back to us, "while we dig these wolf traps to protect the lazy infantry, we must ourselves to fight to drive the monkeys away. The lazy infantry it sleep, sleep; all the time the infantry it sleep."

Laying Out the Roads

So we kept on digging wolf traps. A wolf trap is a hole six feet in diameter and eight or ten feet deep, with a sharp stake in the center. They are planted in front of entrenchments and batteries to

Captain Nicholas Ivanovitch.

make trouble for the enemy when he charges. We dug many wolf traps and marked out many more and left the infantry to dig them while we took up our march.

"It is to build the roads," said the captain. We found three or four regiments scattered over the wide Manchurian plain back of the Sha Ho. The engineers drove stakes and ran their lines, and then their wagons drove along the routes picked out as roads and left a long trail of spades and axes behind. The infantry unwillingly shuffled down to the marks and set to work.

"Ha, ha," chortled the captain. "It is to laugh. Behold the infantry at work."

One road led up over the mountain. It had to be blasted out. "There is no infantry here to do the blasting," said I in my ignorance.

Scorn for the Infantry

"Infantry," snorted the captain, "No, nor never will there be. It is that they can not be trusted to blast. Rather would they blast themselves and the armee from the world. This is the fine work which but they the engineers can do."

So for a day we blasted, and the sound of it was like the sound of a mighty battle. The Japanese heard it from the line south of the river. The Japanese did not approve of our opening that road over the mountain. So they began to drop Shimose shells around us. I thought this would interfere with the road making, and said as much to the captain.

"Ah," said the captain, with the most wonderful sarcasm, "so much have you with the infantry been that always you think you are with them. We, my friend, are engineers."

Working Under Shell Fire

I was squelched. I said nothing more, but meekly sat behind the biggest rock I could find and watched the engineers blasting the rock and hauling away the debris, while the Shimose shrieked angrily through the air and gave splendid imitations of Mount Vesuvius in eruption all around us. I kept tab on the Shimose. Eighty-one shells the amiable little brown gentlemen threw at us that day, but the work went on steadily. The men at first seemed nervous when the shells fell too close, but after a time they never even turned their heads. Thus use doth breed a habit in a man.

"We have not done the things which bring to one the St. George cross or even the Stanislaus and puts our names in the paper and brings the message from His Majesty," said the little captain, as he came back to me black with powder. "We have not charged the enemy or captured many guns or saved the position. We have but made a road over the mountain. That is all. Yet five men, they are dead; six are wounded. We have not fought a battle, yet still, it was not the child's play, and some day when the grand battle, it is raging, and they, the Japanese, are pressing hard down that valley over

there, and it is wanted to save the day that many troops and many guns be pushed to that position over there at the head of the valley, then this road we have builded will save the day because it is the straight line and will be wide and smooth. What say you, my friend?"

Stringing the Barbed Wire

We carried our lines over the hill and left the infantry to finish the work, while we went on somewhere to the southeast, where the engineers had to finish other work they had begun a week or two before on a new line of fortifications. And here we strung miles of barbed wires to form an entanglement, the captain weaving the wires in and out, back and forth, in the most artistic manner. Then we dug a lot of holes with a barrel of powder or several pounds of dynamite at the bottom, and filled the holes full of rocks and connected the explosives with little buttons in the earthwork that had only to be touched and—"Ah, ha!" said the captain, "Poof! Bang. He explodes and flings out the rocks and the Japanese, ah, ha! They die!"

Then we went on to the east, and for three days we made a bridge. It was a beautiful bridge, and I was not surprised that just as soon as we had it finished the Banzai brotherhood should suddenly appear and insinuate that they would like to have it. The insinuation wounded two of our men and put a bullet through the captain's coat.

Fight for a Bridge

The captain was extremely indignant. "Ah, swine that they are," he declared. "Here for three days we make the loafley bridge, and then when all is finished they come to obtain it. Ah ha, is it that we for the Japanese do the bridge make. Have they not then the engineers of their own to themselves their own bridges to construct?"

RUSSIAN ENGINEERS BUILDING A PONTOON BRIDGE.

"Looks like they were going to get it," I ventured. "It will take long to bring up any fighting units. Nothing here but engineers."

The captain grew almost apoplectic. "Nothing here but engineers! Ah! That is your infantry, that is your cursed artillery friendships which talk. Too long have you thus associated with these. You shall see whether what you call nothing but engineers should thus be the sneezed at."

Already our engineers had dropped axes and saws, and, with their rifles in hand, were advancing in extended order from the bridge head. They took cover, and then their rifles commenced to rattle in the most lively sort of fashion. The Japs had halted and had opened a fusillade which did not appear to do much damage, but they seemed to be working steadily nearer, and, as they apparently outnumbered our little command, it looked as though they were going to own that bridge.

Mountain Guns in Action

The Japs bobbed up and made a dash of twenty or thirty yards forward, and then lay down and opened up a hotter fire at the closer range.

Ready to Lay Out a Road.

"Ah!" I said to a young sous-officer with me. "Too bad that we have only engineers. Oh, for a piece of artillery."

"BOOM-M-M-M—" came from behind us like a clap of thunder and a shell went hurtling through the air overhead and burst in a little white cloud over the Japanese line. I looked around. There was Captain Nicholas Ivanovitch, commanding a little mountain gun, which was now pumping shells at the Japanese as fast as it could be worked. This was too much for the Japs. They were only a scouting party and were not prepared to engage in a discussion with cannon, so they slowly drew off.

"Ah, ha!" said the captain, calmly. "You see, we build the bridge, we fight the battle, we are infantry, artillery, and if it was that I put the men on the teams and have them pursue the Japanese, you would see what fine Cossacks are we also—the engineers. But now other things shall you also behold. Look, now do I become a court of the law and justice dispense therewith."

Sending a Spy to Death

Three or four soldiers were coming up to us, dragging a Chinaman between them. He had been found skulking in the rocks below the bridge, and it was supposed he was a Japanese spy. The man protested volubly, but when he was searched Japanese money was found sewed up in his rags. That doesn't sound like very conclusive and absolute proof, but this happened in the East. Things happen different in the East.

The Captain nodded. Two soldiers dragged the Chinaman to a tree and bound him against it and immediately placed their guns to his head and fired.

"It is not that I am without the heart," spoke the little captain in a low tone. "These are things I like not, but it is war and there is naught of war with which the engineer does not have to do."

And I had finally to agree that it was so.

TO A STAR

By Hubert M. Skinner

Eight minutes from their start the sunbeams reach us,
And years must pass for light to come from thee;
The tardy messages of vision teach us
That all is past which now we seem to see.
Yea, all is past that we may see from earth;
We view nor scene nor action at its birth.

And light is ever bearing on its pinions
A record of our doings; evermore
Still carrying through heaven's wide dominions
A pictured record from this earthly shore;
For light flies on while men and worlds grow old
'Tis distance that determines what is told.

To some far station, Troy but now is burning,
Or Rome with Carthage struggling, fierce in hate,
Or Norman William to the northward turning,
Or Colon guiding on his ship of fate,
Or Washington has fought his conflict through,
Or Bonaparte is lost at Waterloo!

The true recording angel, the vibration,
Writes on forever with his pen of rays,
Of every act of man or act of nation,
Unchangeably through all creation's maze.
O where, in all the universe, or when
Is found oblivion for the crimes of men?

SITE OF THE SALT RIVER RESERVOIR.

Greatest Dam on Earth

Enormous Retaining Structure under Way to Impound Waters of Salt River, Arizona, for Irrigation Purposes

By CRITTENDEN MARRIOTT

Staff United States Geological Survey

THE third anniversary of the irrigation law adopted by Congress in June, 1902, saw construction work actually begun on the first of the great national projects for the reclamation of the arid West. Other projects are, indeed, in various stages of active preparation, but only at Salt River, Arizona, is the erection of a great storage dam in actual progress. It took three years to get ready for that.

Yet, when all the difficulties in the way are considered, the wonder is that not so much, but so little time, has been required. When the Reclamation Service (organized as a branch of the Geological Survey, with F. H. Newell, Hydrographer, as Chief Engineer) took charge of the work, it found that all the easy projects had already been undertaken by private capital, leaving for the Government only those that were difficult—difficult legally, financially, and constructionally.

Hard Work of Preparation

The obstacles presented by these were almost without exception of such a character that they could not be cleared away hurriedly. Whether they called for the adjustment of warring property interests, or for the estimating of enormous expenditures, or for the determination of average water supply, they all took time—much time. The fact that they have all been adjusted in the case of Salt River in three years, speaks much for the energy of the Reclamation Service and for the enthusiastic coöperation of the citizens of Maricopa County, Arizona, in which are situated all the lands to be irrigated.

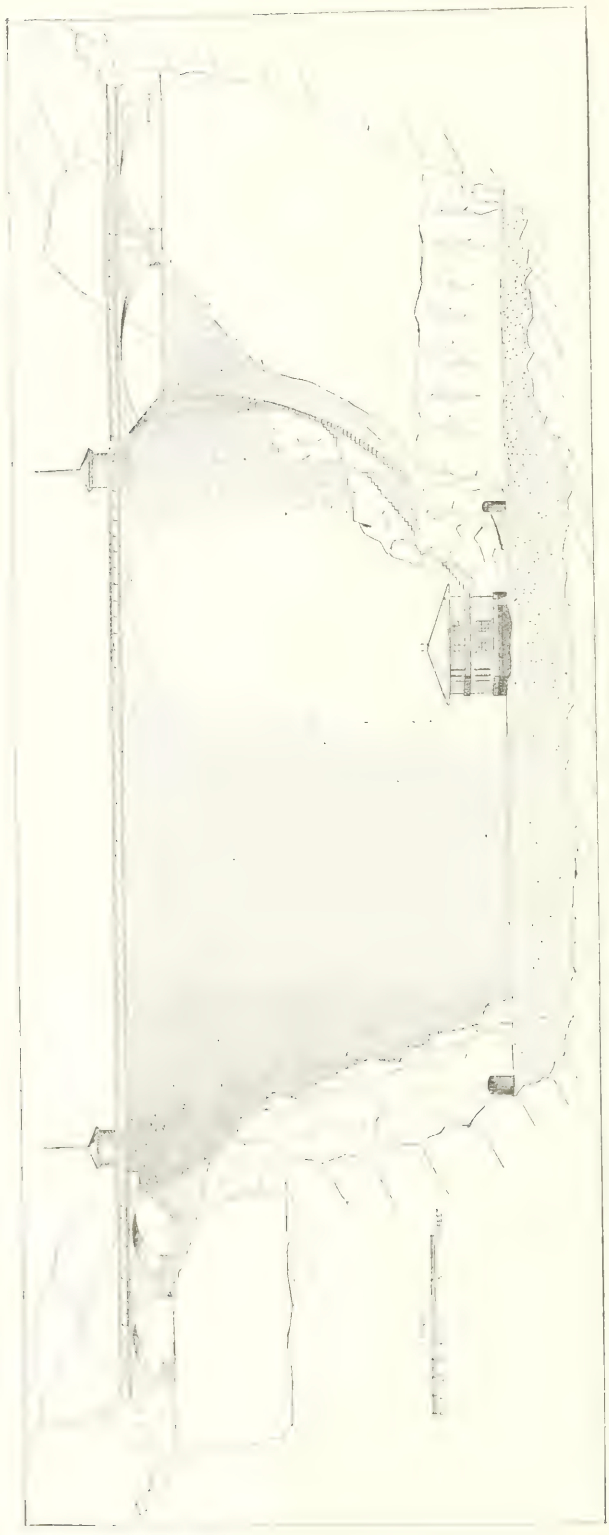
Not a few men would have chosen a small and easy project to begin such a series of gigantic operations as this irrigation work is sure to prove. Not so, however, with the Reclamation Service! The Salt River project is the first to be ready, and accordingly will be the first

to be constructed—and the Salt River project is the very greatest irrigation project in all the world.

Greatest of all Dams

Fifteen years ago the highest dam in existence was the Furens dam (in France), the total height of which was 170 feet. Since then three very much larger dams have been built in the United States. These are the Croton dam in New York, the Clinton waterworks dam at Boston, and the waterworks dam at Denver, on the South Fork of South Platte River. Each of these at present holds the record in one respect or another: the Denver dam is the highest in the world; the Clinton impounds the largest amount of water; and the Croton dam contains the largest mass of masonry. But the Salt River dam, when finished, will exceed each of these in its own specialty; it will be higher than Denver; will exceed the Croton dam in masonry; and will impound twice as much water as all three dams put together. It will be 270 feet high from foundation to parapet, will contain 300,000 cubic yards of masonry, and will impound more than a million acre-feet of water—that is, more than enough to cover a million acres (1,500 square miles) to a depth of one foot. It will form a lake 25 miles long and one to two miles wide, covering an area of 14,000 acres. Its cost, with maintenance for ten years, will be $3,000,000 or $4,000,000.

BORING ON THE SITE OF THE SALT RIVER DAM. DIAMOND DRILL WORK.



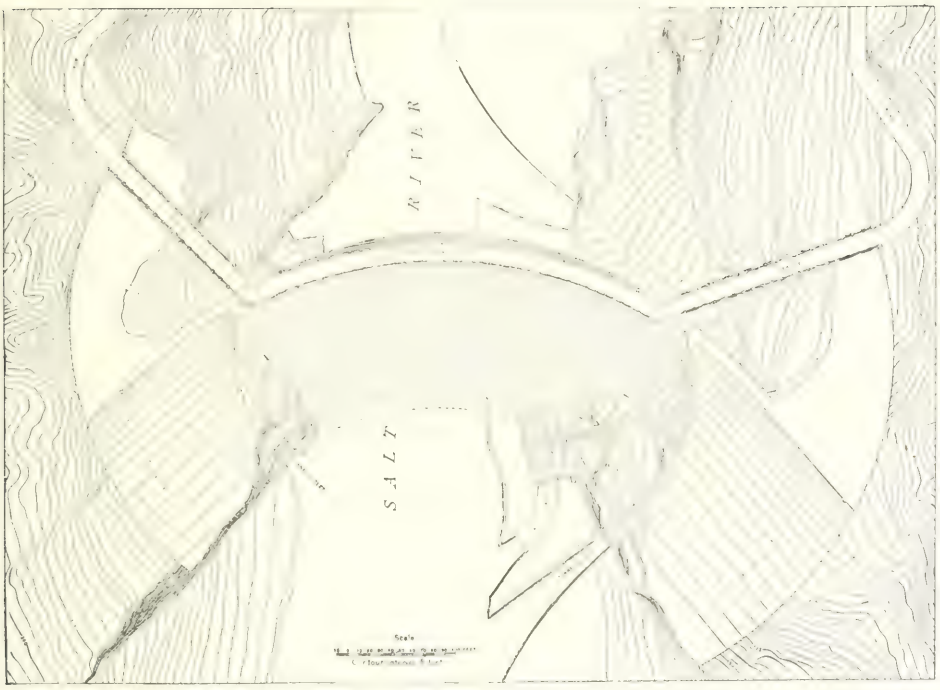
ELEVATION OF SALT RIVER DAM.

Hard to Say Which First

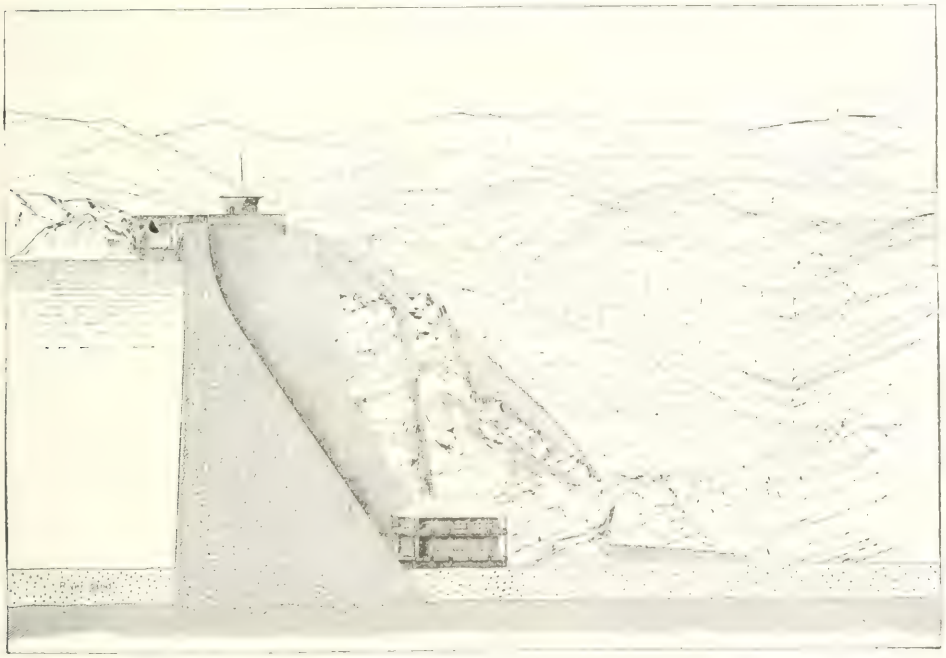
The difficulties in the way of any project are two sorts—those dependent on people and those dependent on things—and people are often the more obstinate of the two. There are ten reclamation states and territories, in each of which—on account of the expense involved—only one project can at present be placed under actual construction. Conversely, each state and each territory has several projects, all clamoring for first place. Arizona has—or had—no less than six. No *ipse dixit* could fix the relative value of all these; it required days and weeks and months of field work before a choice could be made. When at last Salt River was awarded priority, all the conflicting rights—and these were legion—in the land and water under consideration had to be harmonized, and enough of the settlers who would be benefited by the project had to form an association and pledge their lands to guarantee the return to the United States of the money to be expended. Moreover, as, under the law, no man could purchase water for more than 160 acres, those who owned more than this amount had to arrange to part with their surplus holdings. Until enough land was pledged to make certain the return of the money expended, the United States would not act. Money talks; and if enough had not talked on Salt River, Uncle Sam would have considered that the project was not wanted and would have taken his capital elsewhere.

Preliminary Work All Done

But little by little all the preliminaries have been ad-



PLAN OF SALT RIVER DAM.
Showing the Location of the Power House, Power Canal, Tail Race, and Contour of the River Banks.



SECTION OF DAM AND ELEVATION OF SPILLWAY AND POWER HOUSE.

justed. The settlers have formed an association and have pledged their lands for the return of the money expended; the lands required for the dam

F. H. Newell, Chief Engineer of the Reclamation Service, in the Field.

and the reservoir have been withdrawn from entry, where public, and purchased, where private; existing rights in the present flow of Salt River have been ascertained and provision made against infringing on them; and a very close estimate of the total cost and the cost per acre to be irrigated has been made.

Much of the preliminary construction work has also been done. A new and very costly and very difficult road forty miles long has been built from the railroad station at Globe to the dam, which is situated in a very wild and inaccessible spot; a telephone line 70 miles long, connecting it with the rest of the world, has been erected; a cement mill where the 200,000 barrels of Portland cement needed in the work will be prepared, has been completed. All this work, extensive as it is, is merely preliminary to the building of the mighty dam, and is looked upon as a detail wedged in between the years of work of determination that preceded it, and the years of work of construction that will follow it.

Points to Be Considered

The work of determination was, of course, long and careful. As in every other such project, five things had to be specially considered: the possibility of building a dam that would be stable and reasonable in cost; the quantity of water that would be impounded by it; the supply of water that would be available to fill the reservoir formed by it; the practicability of constructing canals to take the water from the reservoir and deliver it at the border of the lands to be irrigated; and the acreage of irrigable lands that can be reached by this water.

The dam site of the proposed Salt River reservoir is all that could be desired. Situated in a narrow gorge only 200 feet wide at the bottom and 800 feet wide at the top, with precipitous sides carved out of solid rock, it offers an opportunity for a masonry dam of the most permanent form known to engineering science. The formation rocks are sedimentary, with strata dipping toward the site at angles of about 30°, a most favorable condition for retaining stored waters. The foundations and abutments are of tough, hard, fine-grained sandstone, and are all that could be desired. Building stone of the same material is at hand in abundance; much of

Assistant Chief Engineer A. P. Davis, in the Field.

Mr. Davis made the first investigations and the plans for the Salt River dam.

that used in the dam will be taken from the outlet tunnel driven through the solid rock at the west side of the dam.

Sand and Cement at Hand

All materials needed for manufacturing good Portland cement are found in the vicinity. Sand for mortar could be

taken from the river bed, but it is thought best to manufacture it by crushing quartzite, thus forming an ideal sand which need not be screened or washed. As power will be abundant, the cost of this will not be great.

Borings were made at the dam site in 1901, at the expense of water storage commissioners organized under the laws of the Territory of Arizona and provided with funds raised by taxation in Maricopa County. The borings proved the foundation to be favorable. On the site finally adopted, the deepest hole to bed rock is 28 feet, and the rock is of the most excellent character. Samples were tested in the crushing machine of the navy yard at Washington, and showed better results than average granite used for building purposes. In fact, the machine used for the testing had never been put under such a strain before.

ABUTMENT WALL OF THE SALT RIVER DAM.

Plan of Great Dam

Across the gorge the dam will be thrown — 300,000 cubic yards of solid masonry, to be laid in Portland-cement mortar in a wedge-shaped section, 16 feet wide at top and 165 feet wide at bottom. It will tower 230 feet above the level of the present river bed, and penetrate 40 feet beneath it, giving it a total height of 270 feet. Two gigantic spillways, each 100 feet wide, sunk 20 feet below the crest of the dam, will provide an outlet for floods too great to be risked against the main body of the dam. When fully opened, these spillways will discharge 10,000 cubic feet of water per second—an enormous flow, but none too great; for these arid-land rivers, when they come down in their might, rival even the Mississippi in their volume. In 1891 Salt River discharged for a few days the almost incredible amount of 300,000 cubic feet per second—enough to fill the entire reservoir in one day. Only about half of this, however, came from the watershed behind the Salt River reservoir, the other half coming from tributaries entering below the dam site.

The reservoir behind the dam extends up both Salt River and Tonto Creek, and can be made to hold almost any amount of water that is desired. Exhaustive surveys were made to determine its capacity, as few things are so deceptive to the eye as the area of a reservoir before it is filled.

Topographic Surveys Made

It is almost impossible to estimate accurately the slopes of the ground or to guess even approximately the distance to which the water will be backed by a given height of dam. Topographic surveys are always disclosing the most extraordinary errors by men who might be supposed to know better.

On Salt River, topographic surveys were made, accurately determing the area and contents of the lake that would be created by each ten feet additional in the

height of the dam from 0 to 200 feet above low water. For a dam less than 100 feet high, the capacity of the reservoir is not extraordinary, but above 100 feet it increases rapidly, and at a height of 200 feet above low water is about a million acre-feet. It would be entirely practicable to construct a reservoir of several times this capacity; but this is not justified by the conditions, the limit to the economical height of a dam being determined by the supply of water ordinarily available for storage.

The various capacities with different heights of dam were learned so that the best height might be selected. A dam too low would let water that might have been saved go to waste; a dam too high would be a useless expenditure of money; a dam of exactly the right height was what was wanted.

Measuring the Water Flow

This exactly right dam could be fixed only by an intimate knowledge, not only of the quantity of water each height of dam would hold, but also a close approximation of the quantity of water that would be available to fill it. To learn this, measurements of the flow of Salt River and Tonto Creek, extending over several years, were necessary. Guesswork based on the mere eye is worse than useless in the case of arid-land rivers. During one year the river will be flooded one month and bone-dry another; in a second year there will be plenty of water all the twelve months; while in a third the supply will be limited even in the rainy months. The danger of guessing was illustrated by a dam built without proper measurements in Mexico a few years ago; the engineer was assured that the supply was ample, and asked to rush the job. He did so, and to this day it stands as a monument to his imprudence, having never been one-quarter filled.

Salt River Measured for Thirty Years

On most of the irrigation projects under contemplation, the flow data are more or less scanty. Government appropriations for such work were begun only four or five years ago, before which time measurements were made in a casual sort of way by the Weather Bureau and by private firms. Salt River, fortunately, was an exception; on it there are complete and reliable measurements extending back for about 30 years, so that there is no difficulty in determining the average flow.

It has happened that an irrigation project, feasible in every other particular and almost on the point of construction, has had to be abandoned because its intended reservoir was found not to lie high enough above the land to be irrigated to permit water to be transferred by gravity. Impossible as error may seem in such a matter, it is by no means either unusual or inexcusable in default of accurate surveys. The reservoirs are usually many miles away from the lands to be irrigated; and though they may be higher, they may easily fail to be enough higher, or there may be some insurmountable obstacle to the construction of a canal—insurmountable, that is, at a cost that will not make the enterprise prohibitive.

No Canals Necessary

In the case of Salt River, however, there are no such difficulties. No canal at all is necessary, the water being allowed to flow down the channel of the river, and being taken out 60 miles away by dozens of canals already built, which are now dry at the very times of the year when water is most needed. The great dam will merely conserve and regulate the flow, saving the superabundant supply of the winter for use in the summer, and saving the surplus of one wet year to make up the deficit of the possibly two or three dry years that may follow it.

It is fortunate that no canal is necessary, as one would be very costly. The wagon road built to the dam site by the Reclamation Service was over country so rough that for seven miles it cost at the rate of $25,000 a mile—as much as good railroad construction. From this it can be imagined what a canal, necessarily built to grade, would cost.

On all Arizona rivers the question of sediment is a serious one. Colorado River brings down every day of the year about 17,000 cubic yards of wet mud; and Salt River, while much behind the Colorado, yet brings an amount that cannot

IRRIGATING IN FURROWS NEAR PHŒNIX, ARIZONA.

be disregarded. Eventually it would fill any reservoir.

Long Tunnel through Solid Rock

To facilitate the removal of this sediment from the reservoir, and also to furnish the maximum reinforcement to the spillways in time of flood, it was decided to draw all water below the eighty-foot level through openings directly on the bottom of the river. For this purpose a tunnel 500 feet long has been cut through the living rock on one side of the canyon. It will be closed, when not in use, by six massive gates weighing altogether 800,000 pounds, and being capable of resisting each a pressure of 400 tons. During construction, which will be carried on night and day until the dam is 150 feet high, this tunnel will be used to divert the stream.

As the ordinary or low-water flow of Salt River has long been entirely appropriated and used for irrigation, it follows that this water must not be diminished in quantity, but must be allowed to flow down the river at all times in the customary manner. Two methods might be adopted to accomplish this purpose. The water could be measured as it enters the upper end of the reservoir and the same amount turned out through the dam; or, preferably, the low-water flow could be taken around the reservoir by a canal and kept entirely away from the stored flood water.

Canal for Low-Water Flow

This last method has been selected, and a canal 19 miles long is now being constructed around the left side of the reservoir. It will take the water from the river at a sufficient height to conduct it over the top of the dam, beyond which it will return it to the river in a sheer drop of 270 feet.

In the construction of a great dam, one of the most important elements is that of power. This is necessary on a large scale for drilling purposes, for handling rock, for mixing mortar, and for crushing materials to be used in concrete. In the

[illegible]

present case, furthermore, it has been found possible and very desirable to manufacture on the ground the large quantity of cement required in the dam. This would require about 300 horse-power day and night, for grinding rock and clinker, and for handling materials and running machinery. It is usual to provide such power by means of steam engines; but on Salt River this would be very expensive, owing to the scarcity of fuel. But the diversion dam built to transfer the low-water flow past the dam to its rightful owners, will furnish all the power needed at the dam by its fall when turned back into the river channel.

Plenty of Power Available

At two other places, one at a spot 7 miles downstream, where the drop will be 70 feet, and one at a point 25 miles downstream, where the drop will be 60 feet, all the water—low-water and storage flow combined—from the reservoir will be used to develop power, which will be transmitted some 60 miles electrically and used for pumping.

This brings up the second part of the great work. Salt River Valley was at some former time a broad, deep valley surrounded by granite mountains. Later it was filled to a great though unknown depth by clay, sand, gravel, and bowlders, forming a loose material which is kept saturated with water, probably by the river and by occasional floods from the surrounding hills. All over the valley this water is found by wells about 200 feet deep. It is not flowing artesian water; that is, it will not rise to the surface when a well is drilled to it. But it will rise within reach of pumps, and is largely pumped even now for irrigation. The three power sites of the Salt River project are expected to develop power, which, when transmitted by electric cable to the proper places, will pump enough to irrigate some 50,000 acres of land. This, with 150,000 or more acres supplied direct from the stored water behind the great dam, will make up the entire irrigable land of the Salt River project—an area equivalent to one-third of that of the entire state of Rhode Island.

The Song of The Flyer

I THROW the miles behind me with a never-ending roar;
I pant with heart impetuous for the miles that stretch before;
With ne'er a pause I leap within the tunnel's yawning mouth;
I stop for naught from east to west, for naught from north to south.

The steel-blue ribbons glow with pride to bear my passing form;
The signals beckon down the line, through sunlight and in storm;
The mountain lions cower when they hear my whistle's blast;
The mountain gorges echo as I thunder proudly past.

I hold the road by right of way, a royal race I run,
Nor stay until my goal is reached, beneath the setting sun.

—A. P. PAYSON, *in Four-Track News.*

Mystery of the Slave Island Gold

Strange Story of an Old Inventor Who Made the Ocean Give Up Its Gold

By HENRY MORROW

I DON'T suppose one man out of a hundred thousand ever heard of the Slave Island gold plant.

Knowledge of it came to me in my capacity as secret investigator for a certain little clique of men, who meet once a week in an upper room in a tall building on lower Broadway, and part of whose business it is to keep exact track of the visible gold supply of the world.

From their agents at each of the great mints in the five continents, they get regular reports of the amount of gold brought in each week, who sells it, and the price it brings. Other agents, acting under direction of this central office, investigate these reports, make sure of their truth, discover, if possible, just where the gold is mined, under what conditions and by what process. If—as occasionally happens—these minor agents find the work

THE OLD MAN CAME RUSHING EXCITEDLY DOWN

impossible, if they are unable to discover all the facts in connection with each considerable sale of gold, the case is turned over directly to me. And I—speaking with all due modesty—have never failed them yet, though the case of the Slave Island gold plant was quite the most difficult and complicated I have ever been called on to handle.

Why They Watch the Gold Supply

What is the object of this great and mysterious organization in going to a vast expense of time and money to keep such close watch on the gold supply?

It is so simple, so really commonplace, that I hesitate to mention it. Yet I doubt if I can make it exactly clear to the average man. And it is precisely because the average man is so stupid, so slow to grasp a really great idea, that my masters of the clique have become the practical dictators of the world's markets.

Listen, then, to the fundamental fact which lies at the bottom of all financial operations:

The value of every other commodity in the world is based upon and determined by the value of gold.

It follows, then:

That any great increase in the production of gold, or any great decrease in the cost of its production, will lessen the value of the precious metal and raise the value of every other commodity.

Does one now begin to grasp the reason why the little group of men, who disguise their purpose under the innocuous title of the One O'Clock Luncheon Club, keep up such a continuous and world-wide watch on gold production?

Fear for Their Investment

The bulk of their permanent investments are in gold bonds, bearing interest payable in gold. And they are obsessed by the dread that some adventurer may discover a vast deposit of free-bearing gold ore, or that some inventor may find a vastly cheaper method of producing and transmitting power as applied to gold mining.

The first fear grows less each year as the hidden corners of the earth are opened up by the picks of the prospector. The second grows continually greater. Everybody knows that gold is found practically everywhere—in the waters of the sea, scattered in minute particles through millions of miles of earth. Given sufficient power at a sufficiently low price and easily available anywhere, and both the sea and the land may be forced to give up their treasure.

It is the fear that such a power may be found that is really at the bottom of the activities of the One O'Clock Luncheon Club. The mechanical engineer is really the enemy against whom the shrewdest of world financiers are fighting to protect themselves and their property.

* * * * *

$12,000,000 in Gold a Year

For three years our reports had shown that comparatively small amounts of gold bullion, the origin of which was unknown, had been regularly sold at various mints. The best work of our minor agents had not been able to find the slightest clue to the location of the mines from which it came. A careful study and piecing together of their scattered and fragmentary reports showed me some curious results. In the first place I discovered that in the aggregate one million dollars worth of this mysterious gold was brought to market every month —$12,000,000 worth a year. Where did it come from?

In each case I found that the gold had been sold by a different broker, to whom the precious metal must have been delivered by the producer, either directly or through some agent. It was plain that a great effort was being made to keep the location of the mine and the identity of the producer a complete secret. These precautions convinced me that I was on the track of something which might well be important to my principals.

Treasure from West Indies

After three months' hard work, I made out one interesting, possibly important, fact, which was true about all of the brokers involved in the handling of the gold. Every one of them was either in, or had connection with, the West Indian trade. Three months more was occupied in going over the bills of lading for two years in the offices of the various steamship companies running ships to the Central American and West Indian ports.

Not once did I find a suspicious package addressed to any one of the brokers who had finally disposed of the gold. But I did note, with satisfaction, the shipment with great regularity, of a large number of packages billed as "Shells and Marine Curiosities" to various obscure individuals in each of the cities where the mints were located. What made it especially significant was the fact that each of them was billed from "Slave Island, *via* Caracas."

I could find Slave Island on none of the existing maps; but, finally, my acquaintance with shipping interests in New York, put me in possession of a mariner's chart on which the mysterious bit of land was plainly marked. It was described as "Barren and uninhabited, supporting no animal or vegetable life, so far as known. Embraces about a hundred square miles of land and lies 236 miles nor'-nor'-east of Caracas, far out of the regular course of steamers."

Starts for Slave Island

I took the first steamer leaving for Venezuela, and when I landed at Caracas I was careful to keep out of the way of the regular agent of the One O'Clock Luncheon Club. He had, I knew, no suspicion that the origin of the gold we were seeking was so close to his own headquarters. Loitering along the docks and in the vinol shops frequented by the turtle hunters and coastwise sailors, I presently fell in with a tall half-breed, who boasted, over his drink, of the profitable trade he had built up with a strange gringo living alone with a couple of blacks on the otherwise deserted Slave Island. I persuaded him to hire me as a member of his crew, and three days later we set sail for the mysterious island. As we drew near its flat, rocky shore, I looked in vain for a tall chimney, such as must mark the location of a stamp mill or other gold-producing plant.

"Where are the buildings?" I asked the Captain, suppressing my excitement.

"There are none on the island," he answered, "except a couple of palmetto thatched huts, where Burgess and his two men live."

I was convinced that I must be on a wild goose chase, for how, without steam power, could $1,000,000 worth of gold be produced by three men every month? The whole surface of the island must have been covered with a deposit of free gold which could be washed out by hand.

Strange Source of Power

Circling round the unbroken shore of the island, we came finally to a narrow opening between two comparatively high cliffs, through which the waves rushed with considerable violence.

"It's in the path of the trade winds," the Captain told me. "Day and night, with hardly a break, the wind blows steadily from the northwest and sends the waves through this strait. Inside there's a wide harbor."

He Boasted of His Profitable Trade.

As we shot through the narrow mouth, I noticed, rising and falling on the waves just inside, several curious arrangements of large buoys, connected with the shore by cables.

At the little dock we were met by an old, white-bearded man, who greeted the Captain gravely and looked at me, the new member of the crew, with questioning, half-suspicious eyes.

"The shipment is ready," he said. Two blacks immediately began to roll several heavy casks down to our ship, and I

noticed with astonishment that neither my Captain nor any member of his crew made any attempt to land.

"It's part of our agreement with Burgess," my Captain told me, "that none of us shall ever attempt to leave the ship when we come in to pick up his freight. His men will put supplies for us on board as soon as they've loaded the casks of shells."

Investigator Stays Behind

I made up my mind at once that I must arrange to be left behind when the ship sailed. On payment to my Captain of twenty dollars, he agreed to let me put off in the small boat as soon as our ship got outside the harbor on the return trip to Caracas. I waited several hours, until the ship was out of sight. Then I boldy rowed in to the little dock again, and the old, white-bearded man came rushing excitedly down to meet me before I landed.

"What does this mean?" he demanded, glaring at me through his big spectacles.

"I left the ship to pick up some dunnage washed overboard by a big wave," I explained. "Then a sudden squall struck the ship and she was blown out of sight. They have given me for lost. I had no place else to go."

He glared at me in silence for a moment. "You may come ashore," he said, finally.

Next morning he set me to work. It was my first duty to help one of the blacks in arranging the floating buoys. Each of them, I judged, was of about one hundred tons' displacement. They were arranged one at each end of the arms of a large, firmly-braced cross. From the point of intersection of these arms, projected a vertical mast, also firmly braced by guys. The whole apparatus was anchored to the bottom of the harbor by attachment to a cemented block having a ring let into it, to which was fastened a heavy chain, which was connected in turn with a heavy upright beam, being the downward projection of the vertical mast. On this beam the framework holding the buoys was so arranged as to be perfectly free to move up and down with the motion of the incoming waves.

Wave Engine Runs Dynamos

I am a mechanical engineer, myself, and I saw at once that the old man had succeeded in utilizing the vast power of the waves. By a wire cable running to a drum on the shore, which in turn was geared to ratchets, spur wheels, and a couple of curious toothed bands, the power thus generated was communicated in a continuous rotary form to a large fly wheel. Here was a source of power which might be multiplied indefinitely, and which was already driving a 300-horse-power dynamo.

I had solved half of my problem, and the solution was one well calculated to carry alarm to my employers, the members of the One O'Clock Luncheon Club. But to what did old Burgess apply this power in order to extract the gold which he was sending to market so regularly?

A few rods back from the dock at the end of the little harbor, grew a thick screen of palms. For my second day's work I was sent back there with one of the blacks. When I saw what was hidden by the screen, which grew in an irregular circle all about the circumference of the island, I gasped. Hollowed out of the bare rock were a series of shallow pools, into which poured a torrent of sea water, forced up by a pump driven by the dynamo. Presently, when the pools were full, the pump was stopped.

Gold from the Sea Water

Overhead the hot sun of the tropics beat down glaringly, and I jumped to the conclusion that Burgess was depending upon evaporation to dry up the water and give him possession of the solid residue. But I was mistaken. Presently the old man himself appeared, and sending us back to the cabin, proceeded to take personal and solitary charge of operations. He came back within an hour and disappeared into the cabin, carrying a small metal jar under his arm. When I slipped out to the pools, so lately filled with sea water, I was astonished to see them perfectly dry and the bottom scraped clean. I was forced to conclude that Burgess had used electrolysis or some other electrical process to hasten the disappearance of the water. How he treated the residue found in the bottom of the pools

I never knew, for none of us were ever allowed inside the cabin while he was at work.

But, even so, my discoveries were startling. Here was a man who was forcing the ocean to furnish power by the use of which it was compelled to give up the minute quantities of gold its water carries in solution. Both the source of power and the supply of gold-bearing water were exhaustless. As he had harnessed them together, they cost practically nothing, and could be operated indefinitely by one man.

Detective Makes His Escape

During the next month, while we were waiting for the coming of the ship from Caracas, I secretly made careful drawings of the apparatus by the use of which the power of the ocean waves was utilized. I dared make no attempt to learn the methods by which Burgess so quickly dried up the sea water and extracted the gold from the residue. But that it was effective and speedy I had plenty of proof. Every day the old man was at work, and on some days he had the tanks filled twice. And after all, his wave-

WHEN I SAW WHAT WAS HIDDEN BY THE SCREEN, I GASPED.

engine was really the important thing!

When the ship finally came into the dock, the Captain hailed me with simulated surprise. He pretended to have thought me lost at sea! That night I slipped away to the mouth of the harbor, and, when the ship came out, I managed to board her. When I made my report to the members of the club in New York and laid down my drawings of the arrangement of buoys, they did not hesitate. In company with one of the shrewdest of them, I was sent back to Slave Island, empowered to offer old Burgess any amount within reason for all his rights in the wave engine.

Old Inventor Strangely Disappears

When we sailed into the mouth of the little harbor again, we were startled to see the place deserted. The buoys were gone, the pools destroyed as if by a volcanic eruption, the very huts burned to the ground. Nowhere could we find a trace of Burgess or of his two blacks. They had vanished utterly.

Perhaps he had simply amassed all the money he wanted; perhaps he had been alarmed by my sudden disappearance. At any rate he was gone, and we have never been able to locate him.

The wave engine? As to that, the members of the One O'Clock Luncheon Club are biding their time. When they have waited long enough for old Burgess to die, in the ordinary course of events, they may have it patented and put it on the market. Or they may decide not to do so. The adoption of the wave engine would mean a revolution in methods of power production; and, above all things else your large capitalist is opposed to revolutionary innovations in any direction. Revolutions mean changes, and he is very well satisfied with things as they are.

Handling Oceans of Oil

How the Abounding Flow of Crude Petroleum is Stored and Transported in California and Texas

By GEORGE E. WALSH

IN 1903 California produced 25,000,000 barrels of crude oil, nearly 70 per cent of which came from the Kern River and Bakersfield regions. From the latter field alone the average shipment, for some time, was 60,000 barrels a day; in the Kern River field more than 900 wells were producing from thirty to four hundred barrels a day each.

This enormous production presently caused a complete congestion of oil traffic. The daily output could not be shipped and there were no facilities for storing it. At first the steel storage tanks in general use were erected in considerable numbers, but the oil flood filled them faster than they could be built. Then, in desperation, oil producers dug great holes in the ground and simply turned their surplus product into them.

Modern Earthen Reservoirs

Necessity in this case became again the mother of a useful invention, for the "hole in the ground," modified and improved, has become the modern earthen storage reservoir, which has been largely adopted in the place of other storage tanks, in both California and Texas.

These earthen storage reservoirs can be built of almost any size and at a comparatively small cost. They thus give to the producer a convenient method of controlling the shipment and distribution of oil, so that prices may be held to a more uniform level and stability given to the oil-producing business as a whole.

TRANSPORTING OIL IN TANK CARS.

The earthen storage reservoirs for crude oil now being built measure from 400 to 500 feet in diameter and are from 14 to 16 feet deep. The largest of them hold 500,000 barrels of oil.

Simply Tamp the Bottoms

When they were first built, the bottoms and sides of these tanks were carefully cemented, but, when crude oil dropped to 17 cents a barrel, producers could no longer afford to use cement. Presently they found that if the dirt at the bottom of the reservoir was simply tamped down, the leakage of oil, after the first filling, was almost nothing. Consequently cement was permanently abandoned in construction of tanks.

The earthen storage reservoirs are roofed over with one-inch plank, covered with tar paper. This is necessary to protect the oil from evaporation and also from rain.

Not until the roof is completed is the oil turned into the reservoir. Millions of gallons are pumped directly from the wells to the reservoir where it is stored until needed. An electric pump is usually connected with the reservoir to pump the oil up again when needed. Some of the latest earthen reservoirs are connected by pipe lines to the steel pumping tanks, which in turn are connected with pipe lines that run to the railroads or markets. It is a simple matter then to draw from the reservoir the oil as needed without extra handling.

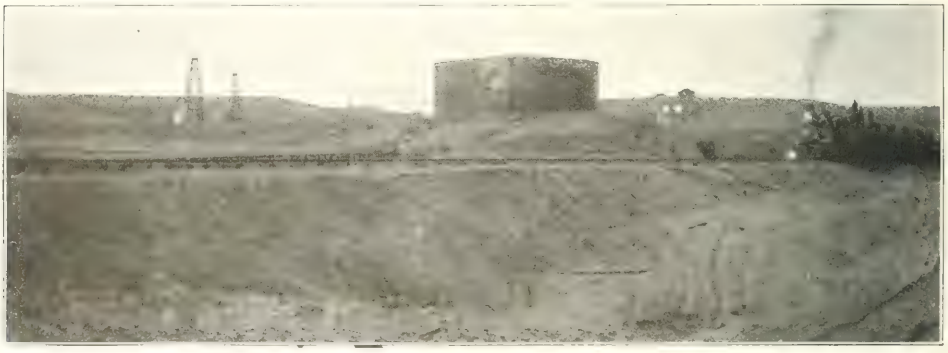
Takes the Place of Coal

The California oil from the Kern River and Bakersfield districts is a very heavy oil, with an asphaltum basis, and not suited to illuminating purposes; but for fuel uses in railroad engines, ocean steamers, and in factories and mills it is eminently adapted. It is also extensively employed in the manufacture of asphaltum and lubricants. All throughout the Pacific Coast it is taking the place of coal for power production, and owing to its remarkable cheapness it is stimulating new manufacturing industries. At present prices this oil is equal to coal at

OIL WELLS NEAR BAKERSFIELD, CAL.

less than 80 cents per ton; and as California in the past paid from $7 to $8 per ton for coal, the difference in the cost of fuel is so great that industrial conditions have been completely changed.

The storage and distribution of oil in the Beaumont region of Texas have not reached the same degree of development as on the Pacific coast. There has not been as large a local market for it, and the question of shipping it to the seaboard has engaged a good deal of attention. Piping it to the seaboard has become a necessity, and the construction of tank steamers to carry it direct to Europe and the Northern markets has been the chief aim of the promotors. With oil selling at 50 cents per barrel in the oil regions, it is estimated that it can be pumped to the seaboard and shipped in oil-tank steamers to the northern coast cities at a profit and sold at 80 and 90 cents per barrel; but there is little disposition on the part of the companies to lower the prices to any such figure.



SANTA FE OIL TANK AT KERN CITY, CAL.

Steel Tanks at Beaumont

The problem of distributing oil to distant consumers is not so important to the large companies as that of storing the supply at some convenient place as needed. The wells which require pumping to secure the oil solve the problem without further trouble, but when new wells are sunk and the oil gushes up in gigantic streams immediate storage facilities must be provided. In parts of the Texas field, great holes were at first simply scooped out of the ground, and the oil allowed to flow into them. Then huge wooden tanks of enormous capacity were built, but these were only temporary makeshifts. The oil exuded through the wood and dripped away in great quantities. Some effort was made to improve the wooden tanks by filling the seams with sawdust mixed with glue, but the wooden tanks were practically abandoned after a few months.

Steel storage tanks of various capacities were constructed by the Standard Oil Company in the Beaumont region, and these were of permanent character, and were not abandoned as were those on the Pacific coast for earthen storage reservoirs. The chief aim of the Texas oil companies appears to be to get their oil to the seaboard as quickly as possible, and then to store it in tanks and reservoirs near the markets. Eventually the problem will reach a solution through the adoption of tanks or reservoirs at convenient points on the coast from which distribution can be made as needed.

The cost of constructing steel storage tanks for oil is one that concerns consumers as well as the dealers in the liquid fuel. With oil as a common fuel for mill and factory purposes, provision must be made for storing it conveniently in receptacles that will minimize the waste. Several of the railroads which use liquid fuel have steel tank reservoirs distributed at various points along their lines, and with their own steel oil-tank cars the supply is always kept well ahead of actual needs.

CLAVICHORD, THE DIRECT PRECURSOR OF THE PIANO.

From Musical Bow to Piano

Interesting Story of the Slow Development of Stringed Instruments

By RANDOLPH I. GEARE

United States National Museum, Washington, D. C.

THE family of musical instruments whose tones are produced by strings, may be divided into three groups:

(1) Those in which the strings are touched with the fingers.

(2) Those in which the strings are plucked with a plectrum.

(3) Those in which the strings are struck with a hammer.

In the first group is the harp and its congeners. The second includes the lute of the Arabs, the Sam-yin of the Chinese, the mandolin, zither, psaltery, etc. To the third belong the "cembals" of the Hungarian gypsies, the Yong-kim of the Chinese, and the European dulcimer—a direct ancestor of the piano, which later instrument stands at the head of the class.

The artisan who discovered that musical tones could be produced by throwing strings of gut and steel into vibration, advanced the invention of the piano very materially, although its mechanism was perfected only after long experiment with a variety of stringed instruments, each of which filled its niche in the evolution of the instrument.

Immediate Ancestors of the Piano

Its immediate predecessors were the dulcimer and clavichord, but the instrument which, so far as now known, may justly claim the most ancient relationship to the piano is the "musical bow," an almost unheard of instrument in these days, but one very dear to the hearts (or ears) of various savage tribes in Africa. Several are here shown from specimens in the U. S. National Museum. No. 1, beginning at the bottom, is from Mashonaland; Nos. 2 and 3 are from Angola;

Musical Bows.

No. 4 is from East Madagascar; and No. 5 from Mozambique. The tone, while weird and melancholy, is said to be far from unpleasant. This "musical bow" was probably the earliest stringed instrument in which the string was *struck,* and this, it should be mentioned, is the essential feature to be borne in mind in tracing the history of the piano.

Other instruments of much later date, and having a close exterior likeness to the piano, are the spinet (or couched harp), virginal, and harpsichord, but in these the strings were *picked* and not *struck:* hence they cannot be regarded as having direct ancestral relationship with the piano. But, in order to gratify the many who connect these instruments historically with the piano in their minds, they will be briefly referred to in their proper order.

Dulcimer an Ancient Instrument

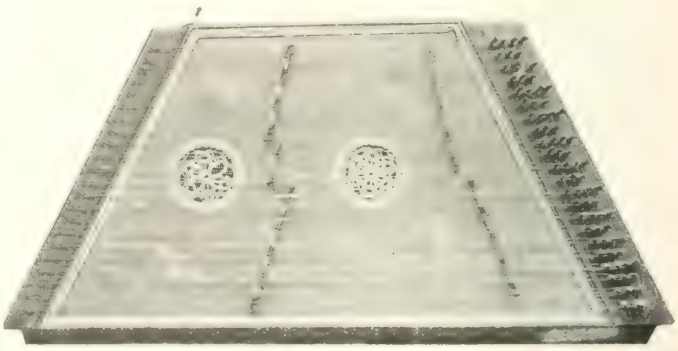
Following the "musical bow," in the time of development towards the piano, comes the dulcimer, which may be described as a trapezoid box, strung with wires, and set in vibration by means of small hammers held in the hand. The dulcimer can be traced back to the earliest ages. In an ancient Assyrian bas-relief in the British Museum is seen a true dulcimer, while in another, representing the triumph after the victory of Sardanapalus over the Susians, several dulcimers are present in the procession.

Similar to the dulcimer in many points of resemblance, is the psaltery, which, however, is a *picked* instrument, played with a plectrum. It may be regarded as the successor of the harp and the common ancestor of the spinet, virginal, and harpsichord.

Spinet Dates Back to 1503

Considerable light has been thrown on the date of the invention of the spinet, by Mr. Edmond Van der Straeten, in his work entitled "La Musique aux Pays Bas," in which, quoting from a list of musical instruments which had belonged to Queen Isabella (dated 1503), he mentions "Dos Clavicinbanos viejos," namely two clavecins or spinets. One of the Queen's chamberlains, Sancho de Paredes, owned "Dos Clabiorganos," *i. e.* claviorgans or "organized clavecins."

From an earlier inventory, dated about 1480, the same official appears to have also possessed a "manichorde," or clavichord with tangents, and earlier yet (1387) we read that John the First, King of Aragon, had heard and desired to possess an instrument called "exaquir," which was certainly a keyboard stringed instrument. He described it as resembling an organ but sounding with strings.



Dulcimer.

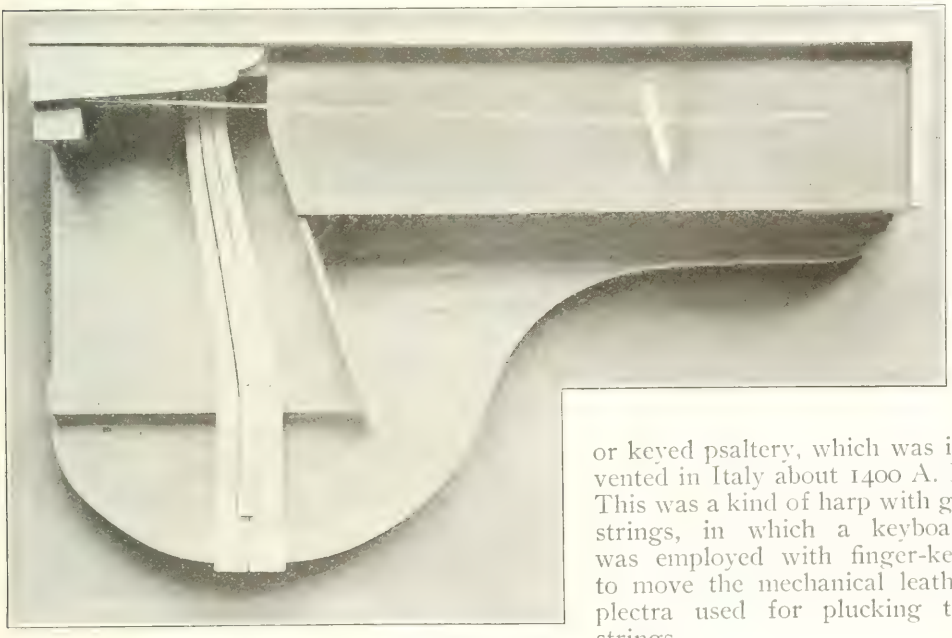
The name "exaquir" is of interest, being identifiable with "échiquier" (chequers) from the black and white arrangement of the keys. Thus we may infer that the nobility of Spain were interested in watching the development of keyboard instruments, and that at least one was in actual use in the Court of Spain early in the fourteenth century.

Mechanism of the Spinet

In the spinet the tones were, as already stated, produced by a series of jacks, which took the place of the plectrum in the psaltery. These rested on the back end of a key-lever, and had movable tongues, working on a pivot and kept in place by a string. A thorn, or spike of crow quill, projected at right angles from the tongue. When the key was pressed down, the jack moved upwards, and the quill was thus brought into contact with the string, which was caused to vibrate. The oldest spinets were without covers, and strongly resembled dulcimers. They had only one wire to each key, whereas the harpsichord had two or more.

The virginal was only a modification of the spinet. It was quite generally used in the sixteenth and seventeenth centuries, and was often called the "clavicymbal." The name "virginal" is variously derived. Some assert that it was so called because it was intended chiefly for the use of young ladies; others believe it was named in honor of the "Virgin Queen" Elizabeth; while yet others assert that it derived its name from the Virgin Mary, to whom the nuns in olden times addressed their hymns, using this form of instrument as an accompaniment.

Both spinet and virginal may be regarded as forms of the clavicytherium, or keyed psaltery, which was invented in Italy about 1400 A. D. This was a kind of harp with gut strings, in which a keyboard was employed with finger-keys to move the mechanical leather plectra used for plucking the strings.

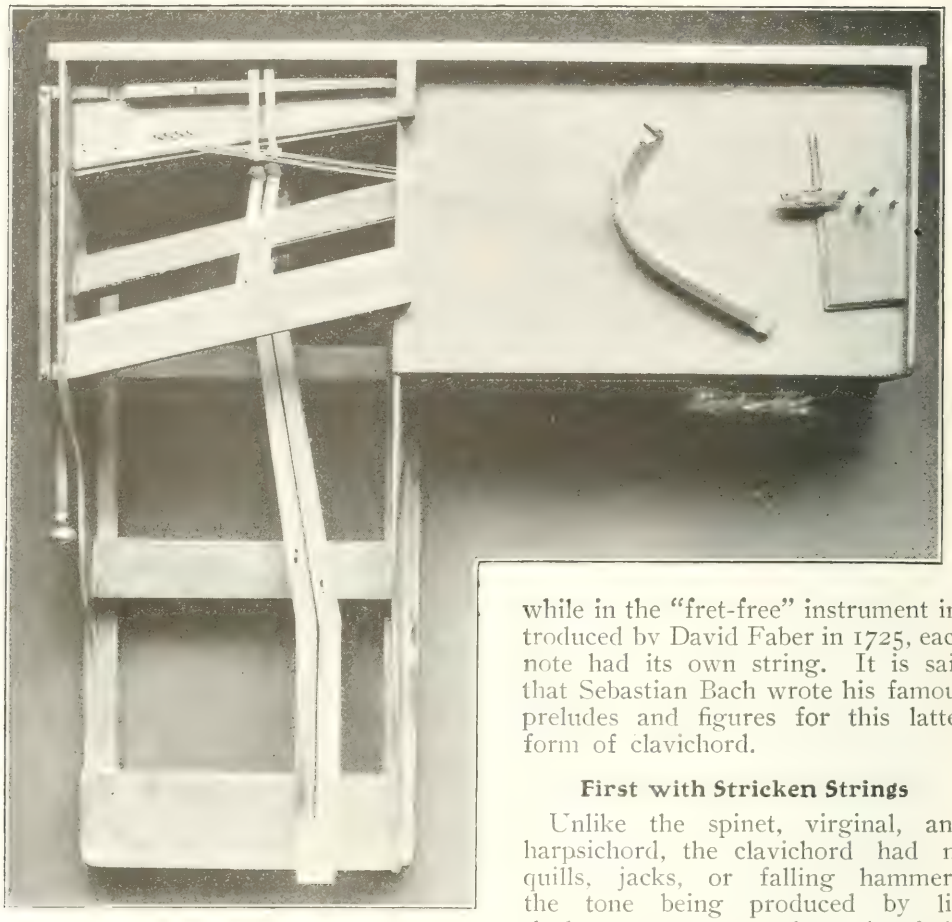


CLAVICHORD ACTION.

Harpischord and Clavichord

Contemporary with the clavicytherium, but differing in the method of setting the strings in vibration, was the clavichord, in which we recognize the *direct precursor of the piano*. Its history will be discussed after an allusion to the harpsichord, which may be generally described as an enlarged and improved form of the spinet and virginal.

In common with several other stringed instruments, the harpsichord first appeared in Italy, and toward the end of the sixteenth century it had superseded the virginal and spinet in many parts of the country. One of the most celebrated makers of harpsichords was Cristofori, a native of Florence, who is also generally regarded as the inventor of the piano.



Old English Single Action.

The harpsichord was strung with steel and brass wires, and contained from two to five strings to each note—quite an important innovation. These were struck with jacks furnished with quill plectra. Stops, swells, and double rows of keys were sometimes employed to regulate and increase the volume of sound.

New ideas were being conceived, and the musical world was gradually preparing for the advent of the piano, which, however, did not appear until the clavichord had in turn held sway.

Just when the clavichord first appeared is not certain, but there is a description of it in an old paper printed at Basle in 1511; and still earlier, under the name of "clarichord," it was comparatively common in England. In a "fretted" clavichord of the sixteenth century, as many as four notes were formed on one string; while in the "fret-free" instrument introduced by David Faber in 1725, each note had its own string. It is said that Sebastian Bach wrote his famous preludes and figures for this latter form of clavichord.

First with Stricken Strings

Unlike the spinet, virginal, and harpsichord, the clavichord had no quills, jacks, or falling hammers, the tone being produced by little brass tangents at the ends of the keys, which, when *thrust against* the strings, acted as both hammer and bridge. This instrument, which was the direct descendant of the dulcimer, was the first one to which mechanism was applied for *striking* the strings.

An old writer described the music of the clavichord as "of a melancholy kind, something like the effect of the close shakes on the violin;" and this description is quite apt, for the clavichord was the only keyboard instrument on which a tremolo effect could be produced. The same writer heard Emanuel Bach play on the clavichord at Hamburg in 1772, and of this performance he wrote "In pathetic and slow passages on this instrument whenever he had a long note to color, he absolutely produced the effect of a cry of sorrow and complaint, such as could only be effected on the clavichord, and perhaps by himself."

Early Days of the Piano

Before alluding to the early days of the piano itself, it seems proper to note briefly the difference between its action and that of the clavichord. The latter consisted simply of a piece of flattened brass wire, called a "tangent," which was placed vertically at a point where it could be struck or pressed against its proper string, the right-hand division of which was free to vibrate, while the left-hand portion was muffled by a piece of cloth, the object of which was also to damp, or stop, the string, which it did the instant the finger was taken off the key. The tones of the clavichord were feeble, soft, and melancholy, and far better suited to the needs of the student and composer than for social purposes. The earliest piano action consisted merely of a key, a lifter, a hammer, and a damper. The key was like that of the clavichord. The lifter was a brass wire with a piece of hard leather as a head. When in motion it impelled the hammer against the string, but allowed it to rebound at once, thus enabling the string to vibrate unimpeded. The damper followed the hammer and stopped the vibrations as soon as the finger was removed from the key.

Cristofori Invents Piano

The invention of the piano, as stated, is generally credited to Cristofori, who in 1709 appears to have exhibited four of these instruments—crude, it is true, and widely different from our modern forms. Especially notable were the smallness of the hammer-head and the absence of any "check," such as is now in use, to arrest the hammer in its rebound. The earliest pianos also lacked control (save through that afforded by the springs) over the forward movement, or escapement, of the "hopper." The hopper, it may be explained, controlled by the springs, effected the immediate drop of the hammer from the strings after a blow had been struck, although the key was still held down by the finger, and could be adjusted to escape from the hammer just before the latter reached the string.

The rebound of the hammer was a very

SPINET.

HARP.

troublesome matter to overcome, and it was the introduction of special mechanism to accomplish this, that constituted "double action" as opposed to the "single action" hitherto in use.

Improved by Germans

Not many years after Cristofori died, the piano fell into disfavor in Italy, partly owing to the imperfection of means for "escapement." Thus the fruits of the invention were reaped elsewhere. Silbermann was about that time devising a pianoforte action in Saxony, and in Germany he was credited with having made practicable the action invented by Schroeter, who claimed that he devised two models of hammer-action between 1717 and 1721, being dissatisfied with the work of his pupils "whenever they chanced to perform on the harpsichord." Silbermann is credited with having made two pianos in 1726, which he showed to J. S. Bach, who condemned them for the "weakness of their trebles and their heavy touch," and pronounced them as only "fit for rondos."

Among others who were early engaged in the manufacture of pianos were Stein, Peronnard, and Tschudi.

Early Pianos in England

In the latter half of the eighteenth century, Johannes Zumpe, of London, began to make square pianos, which were occasionally fitted with drawers, so as to resemble tables—whence in Germany they were called "Tafelklaviere." They became very popular in France and England. The original form was wing-shaped, like that of our grand piano, which, however, was not known till about 1776, its invention being attributed to Americus Backers, a Dutchman, who by the contrivance of the regulating button and screw rendered direct action certain. This ultimately became known as the "English action." The earliest public notice of a pianoforte in England was in 1767, when it was announced, in connection with a performance of the Beggar's Opera, that after the first act "Miss Brickler will sing a song from Judith, accompanied by Mr. Dibdin, on a new instrument called "Piano Forte."

About 1760 twelve German workmen, nicknamed "the twelve apostles," arrived in London and commenced making pianos. One of them, Zumpe, as already stated, produced square pianos, which by reason of their moderate cost and the ease with which they could be handled, sprang rapidly into popularity.

English Improvements Rapid

Tschudi, a Swiss, who had settled in London, became connected with the house, still existing, of Broadwood & Sons, and about 1786 this firm became pre-eminently known as pianoforte makers. John Broadwood assisted Backers in producing the "English grand action," and in 1783 introduced an important improvement in the construction of the square piano, by altering the position of the tuning-pin block (or wrest-plank) from the front of the instrument to the back, a change which has since been maintained. He also made important changes in the construction and position of the sounding-board.

Then came Stodart, Erard, Clementi, Pleyel, Pape, and others, while Germany, too, contributed several inventors and improvers. Among these was John Geib, who in 1786 patented the first valuable "square action." This became known as the "Grasshopper" action, and it held a

leading place both here and in England up to 1840.

Early in the nineteenth century William Southwell, of Dublin, invented the "cabinet upright," and it is said that from this instrument all subsequent modifications of the upright piano have sprung.

Famous American Inventors

America was not far behind in recognizing the merits of the piano. As far back as 1775, John Behrent, of Philadelphia, announced that "he had furnished an extraordinary instrument by the name of the "pianoforte" in mahogany, in the manner of the harpsichord." Nine years later, James Julian advertised "the great American piano of his own invention." Other early makers in America were Charles Allbrecht, George Ulshofer, and Benjamin Crehore. Among the apprentices of the latter were Alpheus Babcock, who in 1825 invented the cast-iron string-plate for square pianos, and John Osborn, with whom Jonas Chickering, the founder of the celebrated house of Chickering & Son, learned the business.

Chickering's "circular scale" for square pianos followed the introduction of the full metal plate, and became the key to the development of the system of "overstringing," or crossing of sections of the strings. This system was intended to divide up the tensional pull of the strings on the string-plate, to economize space, and to insure the instrument staying in tune and up to "pitch"—two most important essentials of a satisfactory instrument, as we all readily understand.

HARPSICHORD.

Many Modern Improvements

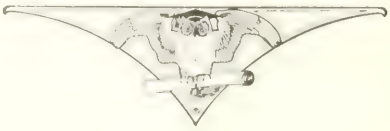
With these same ends in view, several other men experimented, but it is believed that Steinway & Sons must be credited with having first applied overstringing successfully. A piano construct-

ed by them on this plan was exhibited at the American Institute Fair in 1855, for which they were awarded a gold medal. Another important feature of their piano consisted in placing the bridges farther in on the sounding-board, and thus bringing into sympathy hitherto unused sections of its surface. In 1859 this firm was granted a patent for a string-board for "grand pianos," in which the strings were spread out in fan shape, the construction of the plate was greatly improved, and a superior quality of wire was introduced.

At this point the evolution of the piano may be regarded as established, although many additional improvements have been made by later manufacturers both here and in Europe. These would be too numerous to even mention in this place, but in the aggregate they have rendered possible the production of the highest form of piano now on the market.

The illustrations have been carefully selected from specimens in the collection of musical instruments now to be seen in the U. S. National Museum at Washington.

VIRGINAL.



Jersey Wars on Mosquitoes

State Authorities Fighting a Hard Campaign Along Its Whole Coast Line

By JOHN ELFRETH WATKINS

THE first man to successfully wage a state-wide war against the pestiferous mosquito is Dr. John B. Smith, official entomologist of New Jersey—that commonwealth long famed as the shore-line paradise of the insect named. Through application of practical methods devised by Dr. Smith, the watering places of the New Jersey coast are fast being delivered of their only obstacle to creature enjoyment.

Dr. Smith's office is at the state agricultural station, but his laboratory extends from Sandy Hook to Cape May, and all that lies westward to the Delaware. Wading through its dismal swamps, its salt marshes, its stagnant pools, his boots thigh-deep in mire, his net plying the air and his specimen bag at his side, he has found mosquito species never dreamed of before and has knocked in the head about every theory that other entomologists have advanced as to the flying Jersey scourge.

That all mosquitoes had about the same habits and methods of development, and that they attempted nothing like a real migration, was firmly believed until Dr. Smith began this splashing about in the fresh ponds and salt marshes. People

DR. JOHN B. SMITH.
State Entomologist, New Jersey.

were oiling ponds galore, likewise pools and ditches and even running streams. Then they sat down to congratulate themselves that the pest was wiped out forever. But in the midst of their hoping for better times came great swarms of immigrant mosquitoes, "worse than any before."

The idea that mosquitoes never fly far from their breeding place has been, hitherto, the basis of the conclusion that their control is but a local matter. But Dr. Smith lately discovered that certain species migrate for such distances as to make their control a state rather than a local problem.

TYPICAL BREEDING POOL.

POOL IN WHICH 10,636,704 YOUNG MOSQUITOES WERE COUNTED.

Therefore he obtained an extra appropriation of $10,000 from the legislature and set to work. The salt marsh mosquito was found to be the particular species which migrated inland to the greatest extent, and his haunts were made the base of state operations.

House Mosquito Stays at Home

The common house mosquito, infesting towns away from the sea, was found not to have this nomadic habit but to be imbued with a feline loyalty to his place of birth. The malarial mosquito, on the other hand, sometimes traveled and sometimes stayed at home. A south warm wind was seen to carry the nomadic pests for miles in a single night, and on quiet evenings they were found to fly inland for long distances, even against a light breeze. Dr. Smith further discovered that warm west winds will carry swarms out to sea, where they perish. Such swarms have been met fifteen miles out.

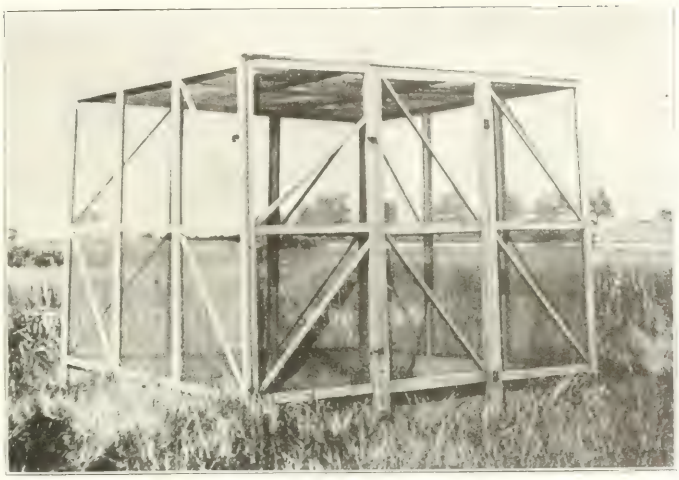
Forthwith, the entomologist went to the root of the evil caused by the migrants. He saw that their breeding areas were so extensive and widely distributed that the oil treatment for the killing of freshly hatched "wrigglers" was out of the question, so far as the seashore species was concerned. He knew that mosquitoes breed only in water, and that if all standing surface water in whatever locality were disposed of the mosquito problem would be solved.

Ditching the Salt Marshes

Lining the entire seashore is an endless chain of marshy homes of these troublesome migratory pests. A marsh of this character is like a huge sponge, and becomes dry only after a long drought. Dr. Smith discovered that when a ditch was opened from thirty to sixty feet on either side of the typical salt marsh, all of the water in such a breeding place would drain into these openings and run out into the surrounding or bounding current of salt water. Such ditches had to be at least two feet deep. Short ditches were dug more cheaply by hand, but where the area to be cleared was large, ditching machines did much cheaper work, costing little over one cent per running foot. Three to four thousand feet of ditching, two

feet deep and from six to twelve inches wide, are thus being cut in a single day.

Another heresy was that mosquitoes may develop in grass and shrubbery, but Dr. Smith finds that no species can breed out of water. In a large cage on a mosquito-ridden meadow he closely studied their habits. During the early "wriggler" stage the mosquito is purely an aquatic animal, absolutely helpless on land.

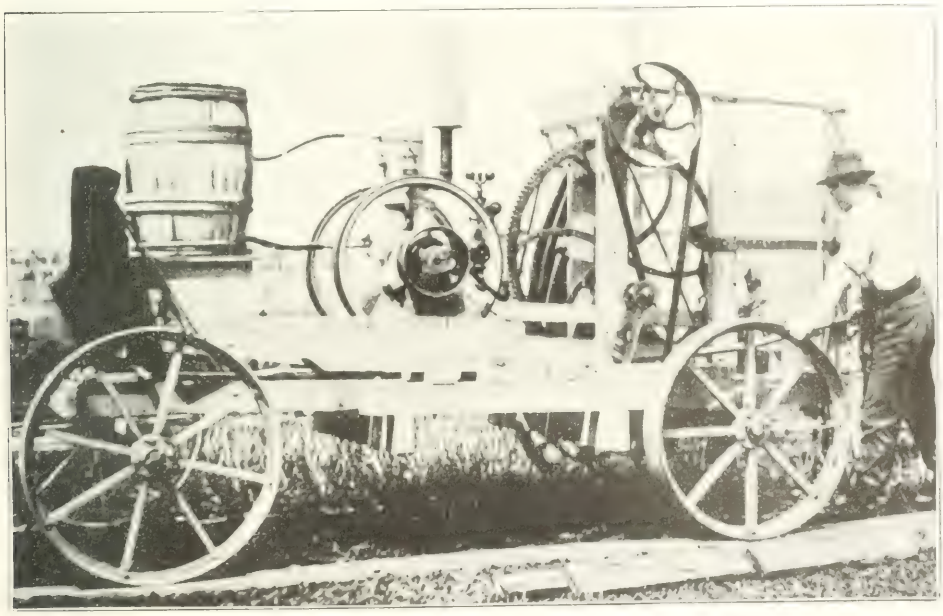


DR. SMITH'S EXPERIMENTAL MOSQUITO CAGE AT NEWARK MEADOWS.

Fish Are Their Enemies

Water areas containing fish are safe so far as mosquito breeding is concerned, as the fish eat all of the young "wrigglers" before the wings are grown and the aërial mosquito is formed. But in the grass-tangled surface pools formed in these marshes, fish cannot thrive; hence the wriggler has no enemy there and can grow and fatten to his heart's content. The same is true of inland pools of rain water which cannot drain off. Any permanent pond or pool can be made mosquito-proof by cleaning up the edges and stocking with fish. Every fountain or artificial water basin, no matter how small, should be stocked thus, if only with gold fish, Dr. Smith advises. Running streams are usually safe except in the quiet eddies.

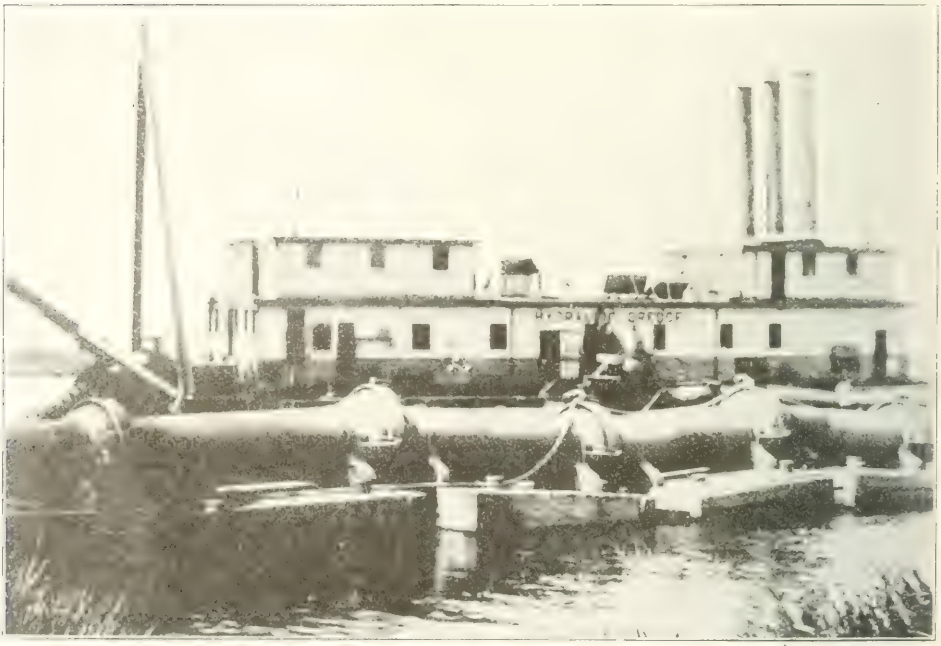
Salt ponds on the marshes never breed full-grown mosquitoes, he finds, because they have perpendicular banks, and are stocked with marine life at every tide.



DRAINING A MOSQUITO MARSH WITH DITCHING MACHINE.

HYDRAULIC DREDGE FILLING MOSQUITO MARSH, NEW CAPE MAY, N. J.

A successful method of exterminating mosquitoes by leveling the marshes and preventing the accumulation of stagnant water.



HYDRAULIC DREDGE USED FOR FILLING MOSQUITO MARSHES.

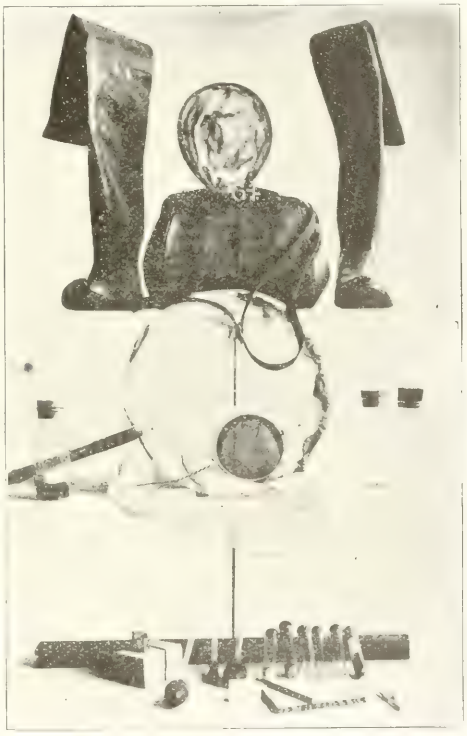
Indeed a marsh that is submerged at every high tide can never breed mosquitoes; but the marsh above high tide, from which the water drains incompletely, is the chief danger source. His scheme of ditching has done away with mosquito hatching wherever it has been tried.

Fire and Hydraulic Dredges

Where a depressed area occurs in an otherwise safe meadow at a considerable distance from a natural watercourse, Dr. Smith has this converted into a permanent salt pond, with steep banks, and stocked with "killies" from the nearest natural water. He further finds it advisable to burn over a marsh not used for hay, as mosquitoes shun burnt areas. The burning tends also to the leveling and drying out of the marsh. He predicts that these great mosquito hatcheries having been thus drained, or perhaps leveled, too, so that there is a natural outlet for all water falling upon or covering them, will remain mosquito-safe indefinitely, if the ditches are looked after each year. In some localities a large per cent of the mosquitoes are hatched from eggs not laid in the salt marshes, but in pools among the sand hills just back of the shore line. These breeding places need simply be filled in with some of the sand surrounding them.

MOSQUITO PARADISE CAUSED BY BUILDING RAILROAD WITHOUT PROVISION FOR DRAINAGE.

In a single pool in the marshes of South Cape May were found 10,636,704 "wrigglers," or 5,616 to the square foot of surface.



DR. SMITH'S MOSQUITO-COLLECTING OUTFIT.

The heavy artillery of the New Jersey campaign against mosquitoes is the hydraulic dredge now being used to fill in vast meadow tracts, which cannot be otherwise drained without great difficulty. These, pumping sand and gravel from a distance and filling sunken meadows at the rate of three acres a day, will work throughout the present summer filling the Kearny meadows between the Raritan and Hackensack rivers. This, one of the worst natural mosquito hatcheries in the world, is passed by all travelers who enter New York from the south and west by the Pennsylvania system. Similar dredges are also being employed at Atlantic City and New Cape May.

MACHINE FOR CUTTING DISCS OF GLASS, AND ROUGH-GRINDING LENSES.

Four Years' Work on One Lens

Delicate and Tiresome Task of Man Who Grinds Object Glasses for Large Telescopes

By JOHN L. COWAN

THE first lens was a raindrop; and the first optical demonstration was the rainbow. How long ago men began to imitate nature in the making of lenses, we cannot even guess. In their crudest form they were made by filling hollow glass globes with water, and were used as magnifiers and burning glasses. A ground lens of rock crystal was found by Layard, among the ruins of Nimrud; but if lens grinding was practiced by the ancients, it was numbered among the lost arts and remained forgotten for many centuries.

Among modern peoples the ground lens was first used in the making of spectacles, becoming common for this purpose early in the fourteenth century. This form of the lens is still the one with which we are most familiar. In the photographic camera we see it in a higher form of development; and in the great object glass of a telescope it reaches its highest perfection.

Raw Material Imported

Little high-grade glass suitable for lenses is made in the United States. That used in this country is nearly all imported from France or Germany. It is shipped in pieces a little larger than the sizes of the lenses to be made, the two surfaces being polished just enough to enable experts to determine by looking through that there are no defects in the glass, the edges being left rough excepting at four opposite points. Much time and care are spent in the examination of the rough blocks, for if they contain the slightest vein or trace of unequal density they are entirely worthless, and any time spent in grinding or polishing would be wasted. It is also imperative that the discs shall be perfectly annealed, which is readily determined by means of polarized light. Small bubbles can be overlooked in large optical discs, as they do no more than slightly retard the passage of light; but defects of any other nature are fatal.

Two kinds of glass—crown and flint—are used in the construction of a lens.

First of all, the focal length of the lens must be decided upon; and then it is necessary to establish by mathematical calculations the exact curves by which the greatest possible effect, with regard to the refraction and diffusion of light, can be secured.

How the Lens Is Ground

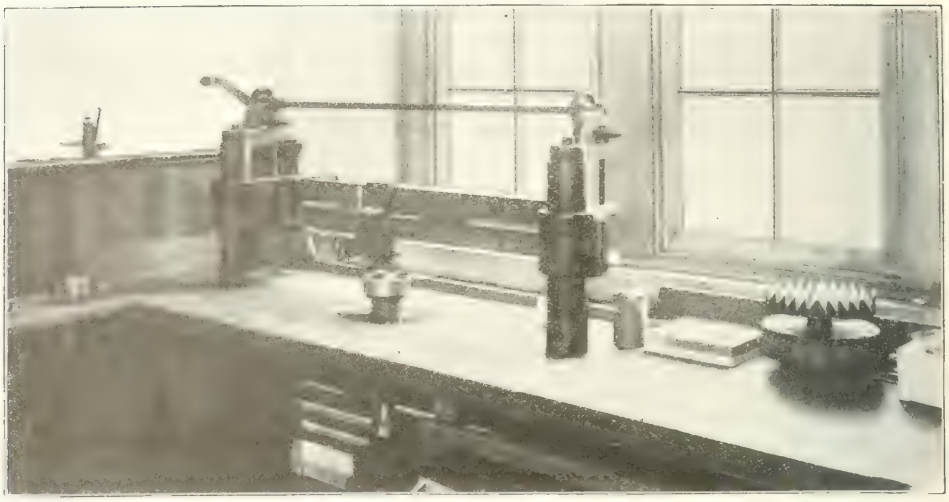
The whole effort of the lens grinder is now directed to the production of the exact curve that has been decided upon. The piece of glass is ground on an iron disc of the proper curve, revolving in a circular trough. From time to time powdered emery and water are thrown on the disc. Most of the time the lens is held in the bare hands of the workman, it being but rarely during the whole process of manufacture that machinery can be used in its manipulation.

When it has been ground down to something near the required shape, it is taken to another slowly revolving tool, where a finer grade of emery is used; and from this to still another; and so on, until it has been reduced to the proper size and has gained approximately the required curves. The last grinding, called the "fining" process, is the most important, and requires the most careful manipulation. The selection of the emery to be used is of prime importance, as a coarse abrasive particle might result in spoiling the labor of months. Several pounds of emery powder are thrown into a vessel of water. All the particles that float are carefully taken from the surface, and what is left is washed for 12 minutes. The water with the emery remaining in suspension is then used for fining. A washing for a shorter period produces a coarser grade, which is used at an earlier stage, and so on.

Marvelous Work of Polishing

The lens is next taken to the polishing department, where the most delicate work of all is done. For the larger lenses, the polishing and correcting are done on massive machinery, in an apartment where the temperature is kept absolutely constant. The windows are never opened here when a lens is in process of manufacture, as a stray particle of dirt from the outside world might work irremediable havoc; and the workman and the precious piece of glass in his hands are protected by a huge umbrella or other non-porous covering from dust particles

LENS-GRINDING MACHINERY.



MACHINE FOR CENTERING LARGE LENSES.

that might fall from the ceiling. This extreme caution is none too great, as the optician must now deal with errors not greater than the five-hundred-thousandth part of an inch.

A mixture of coal tar pitch and oxide of iron is put on the plate of a revolving wheel, and on this the lens is placed. The workman still holds it in his hands, and from time to time adds more of the mixture. To the novice this thing of standing all day long over a piece of glass, and watching a wheel slowly revolve under it, with every faculty of the mind concentrated on the action of watching, seems tedious and monotonous beyond description. It would seem that human nature would rebel against the continual grind, grind, grind, day after day, week after week, and month after month; and that carelessness and inattention, with consequent disaster, would result. However the skilled lens grinder has cultivated the faculty of attention to such a degree that he is oblivious to all but the piece of glass in his hands. The time passes unnoticed, and not until the day's work is done does physical exhaustion from the continual strain on both nerves and muscles assert itself.

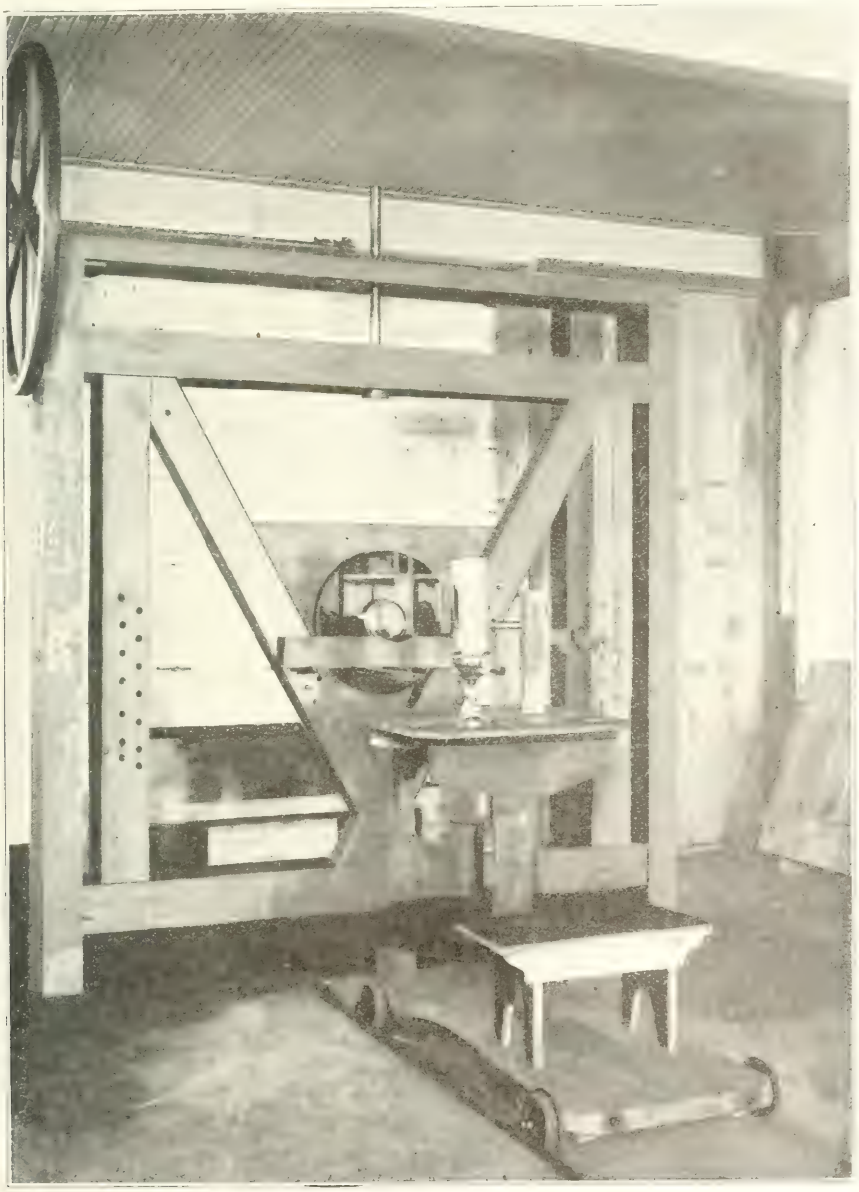
HAND POLISHING LENSES.

Fine Lens Not Yet Finished

After the lens has been polished to about the right degree, a careful test is made to determine that each curve is rigorously accurate to the calculated radius; and it is then centered on a machine that makes the edges of exactly equal thickness all around. At this stage of the work on a fine lens, the ordinary observer would consider it finished; but the educated optician considers it just

begun. Now what is called the "figuring" of the surfaces must be commenced. This is a process calling for the utmost refinement and delicacy of manipulation of the surfaces of an object glass, so that every ray of light coming from the distant stars shall be brought to one exact focal point.

To make such a study of an object glass, a perfectly plane surface must be prepared, which in itself requires the very highest skill. Some of the plane surfaces used are so nearly perfect that on the assumption that they are either slightly convex or slightly concave, the radius of the curve is greater than 1,000 miles.



THE COLLIMATOR IN THE UNDERGROUND CONSTANT-TEMPERATURE ROOM.
Here the lenses are tested for the accuracy of their optical surfaces.

Work That Takes an Artist

Once a plane mirror has been secured, it is used in the delicate study of the optical character of the objectives by simply placing them in front of the plane mirror and allowing the light from a tiny artificial star placed at the focus of the lens to pass through the lens and be reflected back from the mirror through the lens to the eye of the observer. He is now able to trace every high or low zone.

Then comes the fine art work of cutting down the high zones—some of them less than the two-hundred-thousandth of an inch high—and producing a symmetrical curve, which must be a composite of all the curves. But few men ever succeed in reaching this stage in the making of optical instruments. Professor Newcomb has said that their number in each generation the world over can be counted on the fingers of one hand.

In the final work on a great object glass, patience and time, as well as skill, are essential. After working for a few minutes it is necessary to wait for many hours until the subsidence of the surfaces, elevated by such working, can take place—and then only when the temperature is kept constant.

As already mentioned, two kinds of glass, crown and flint, are used in conjunction for astronomical lenses, the combination of the two neutralizing the prismatic light waves, which otherwise would prove annoying to the user of the instrument. With the smaller lenses a transparent cement is often used to fasten the two sections of the complete lens together; and so carefully is this done that the keenest eye can discover no trace of the junction.

It may give some idea of the care and labor required in the making of a large lens, to say that at least one year's time is required for the grinding, finishing, and polishing of a thirty-inch object glass. A forty-inch object glass, completed some time ago, was four years in process of manufacture. A little lens two inches in diameter requires the unremitting care and attention of a skilled workman for nearly two days. The lens is one of the most perfect productions of human skill, and has yielded some of the most wonderful results attained by man.

The Hills of Joy

SORROW cometh to destroy:
Let us seek the hills of Joy
Leave the valley of despair:
Only shadows greet us there!
In the valley is but night:
On the hills is living light!

Sorrow saddens all our dreams:
Joy, a star in tempest gleams!
Let us pass from grief and gloom
Where eternal lilies bloom!
Sorrow cometh to destroy:—
Light shines on the hills of Joy.

The Speaking Arc

Describing the Theory and Showing Several Methods of Construction of this Experimental Device

By A. FREDERICK COLLINS

Author of "Wireless Telegraphy, Its History, Theory, and Practice"

SINCE the early inventions of Reiss, who is sometimes credited with having been the first to evolve an electric speaking telephone, quite a number of electrical, mechanical, and electro-mechanical devices have been found that were capable of reproducing articulate speech. Among the better known devices in this class is the Bell telephone in its original form, now merely designated as the receiver, the Edison phonograph and his motograph, the tin foil condenser, the plating bath, and—the most novel of all in virtue of its being last—the speaking arc.

Devices for Reproducing Speech

While the phonograph is based on strictly mechanical principles, the Edison motograph and the condenser reproducer, which are loud-speaking telephone receivers, are electro-mechanical in their operation; the electrolytic bath is electro-chemical; and the speaking arc is electro-thermal.

The speaking arc, or arcophone, as it has been called, is rapidly forging to the front, and must in the course of a short time emerge from the scientific toy stage and take its place among the other useful electrical products. To the present time the speaking arc has been known chiefly through its adaptation to the needs of the photo-electric telephone in which the human voice or other sounds are transmitted by a beam of light; but there are divers other uses to which it may be put and among these may be mentioned its application as a telephone repeater, as an advertising medium, a public speaker, a wireless telephone transmitter, etc.

Principle of the Speaking Arc

Before describing how these interesting and up-to-date novelties can be brought about by anyone with a little knowledge of electricity and the necessary current, or how the speaking arc may be produced, a foreword as to what the term really means should be inserted; for while it is admitted that nearly every person has heard of it and the marvelous results it works, yet it is doubtful if many have looked up the theory it involves or know exactly how it is constructed.

The speaking arc, or arcophone, consists of an ordinary arc light supplied from either a direct-current generator or a storage battery in combination with a telephone transmitter so arranged that, when the latter is spoken into, the arc acts as a loud-speaking receiver and reproduces faithfully the words just as does the ordinary telephone. Since the arc operates on a 110-volt current, and the ordinary telephone transmitter will not take more than 25 volts, it is obvious that some means must be provided to prevent any excess of voltage which would burn it out.

This apparent difficulty has led to a number of arrangements, two of which are shown in the accompanying diagrams, and either of which will be found to give exceedingly satisfactory results. The first one is designed along the lines of that originally introduced by Prof. H. T. Simon, who discovered the sound-reproducing properties of the electric arc in 1897.

By referring to Fig. 1, it will be observed that the arc light X is connected in series with the source of energy D.

Shunted across the arc is the secondary of a small transformer coil S, and in either arm of the circuit are the condensers C and C_1. The terminals of the primary of the transformer P are connected to the transmitter T, the battery B supplying the local current.

Arrangement of Circuits

It is easy now to follow the consecutive effects that are produced when the combination is in operation. The air waves are converted into electric undulations, the latter impinging on the heavy current supplying the arc, and this superposed current inducing variations of temperature, the former reacting on the air and not only reproducing the spoken words but amplifying them as well.

When the air-waves set up by the voice come in contact with the diaphragm of the transmitter, it vibrates accordingly, as

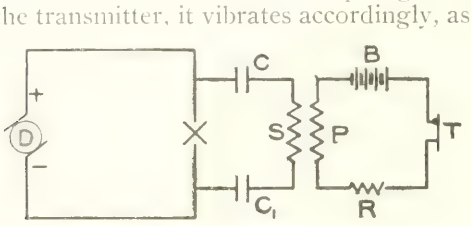


Fig. 1. Diagram of Connections.

in the ordinary telephone, and this causes a varying and corresponding pressure of the carbon granules placed in the primary circuit with a battery. This pressure variation modifies the resistance of the circuit through the granules of carbon, and consequently changes the current itself. The undulatory current passing through the primary circuit of the transformer or induction coil induces an alternating current in the secondary coil, which is then superposed on the direct arc-light circuit.

If the ends of the carbons of an arc light are separated a short distance while the current is passing, the points become heated to incandescence and a vapor column will form a conducting path between them so that the current will not be interrupted but will form an arc instead. The crater of the upper or positive carbon has a temperature of between 3,000 and 3,500 degrees Centigrade, and at this temperature the carbon vaporizes. While this is going on, a violet light which is the arc proper is formed, and around it is a luminous band of a golden yellow color. Although the light values of an arc do not concern us here, it is interesting to note that while the crater gives out from 80 to 85 per cent of the light, the arc itself gives out less than 5 per cent.

When the current which produces the arc is increased or decreased, the size of the vapor column will grow larger or smaller as may be easily seen if the change is made slowly. Where this variation takes place rapidly, the eye cannot follow its changes, though, if the light is projected upon a selenium cell in circuit with a telephone receiver, this difference may be heard; and this is, in fact, the basis of the photo-electric telephone.

When the changes are produced with sufficient rapidity—as by the voice, which gives approximately 800 to 1,000 vibrations per second—audible sounds will result, since the vapor column depends upon the temperature of the arc, the temperature varies with the current strength, and these deviations in temperature cause a sudden expansion and contraction of the air, which in turn sends out sound waves. As Duddel has pointed out, the sensibility of the arc to small variations in the current supplying it is indeed surprising, and as small a current as one-thousandth of an ampere, if passed through an arc taking ten amperes, will produce a distinctly audible note. It was this remarkable property of the arc that led Simon to conclude that it might be used as a telephone receiver.

Requisites for Experiments

There are two essentials in the production of the speaking arc that, carefully looked after, will insure success to the experimentalist. The first is a good transmitter, and the second a long arc. In my own experiments in wireless telephony, I have used an arc-lamp with a hand feed, as well as an ordinary hot-wire lamp, and these were operated on both a dynamo and storage battery circuit. The latter gave the clearest articulation though the former was generally quite satisfactory. A Devean transmitter was used, but any good transmitter will operate with good results if the proper amount of energy supplying it is had.

As the sound waves are produced by the variations in the volume of the vapor column, it is natural that the loudness will depend on its size. In order to obtain loudness it is therefore necessary to use a long arc and a current of fairly good strength. Cored carbons must be used, as there is not enough vapor given off by the solid ones to permit other than a very short arc to be drawn. In an arc formed between solid carbons, there is a great fall of potential close to the positive carbon; but in an arc between cored carbons there is a more uniform drop of potential all the way across it.

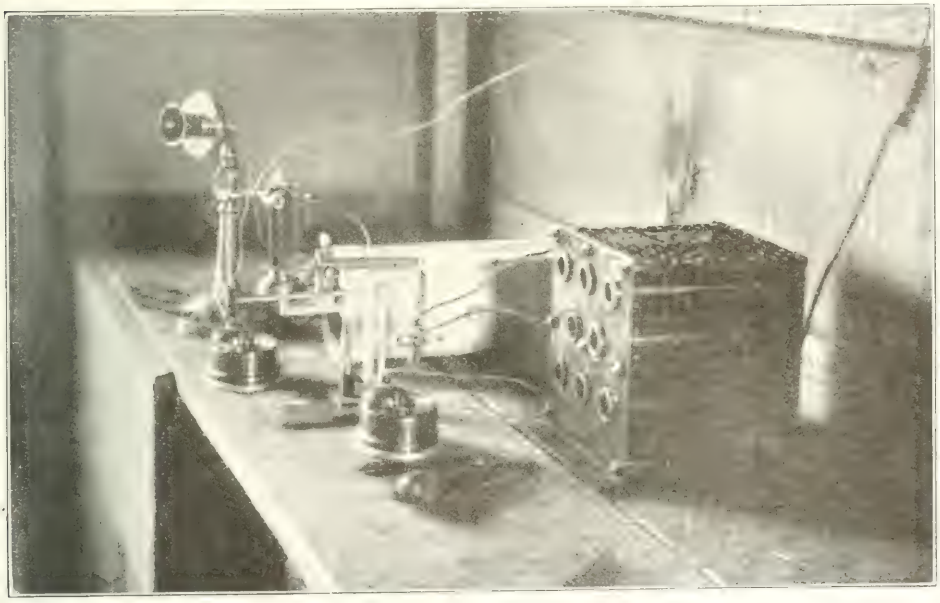


FIG. 2. THE SPEAKING ARC AS APPLIED TO COLLINS SYSTEM OF WIRELESS TELEPHONY.

The positive carbon is therefore impregnated with foreign substances. Exceedingly long arcs may be obtained if the experimentalist cares to go to a little trouble, for a greater percentage of extraneous matter than is contained in the commercial cored carbon may be introduced. An easy way to do this is to use a glass rod as a core to one of the electrodes, the sodium from the glass making it easy to burn an arc an inch or two long.

By again referring to Fig. 1, it will be seen that while the alternating current set up in the secondary current by the telephone transmitter is superimposed, the heavy direct current is opposed by the condensers and the coils. A battery of any kind that will give from 10 to 20 volts will suffice to operate the primary circuit in which is included the transmitter. The induction coil T may be wound for any ratio of transformation, or it may be wound to unity; that is, the wire of which the primary and secondary are formed may be of the same size, have a like number of turns and a similar number of layers.

Thus both may be made of No. 14, Brown & Sharpe gauge, cotton-covered magnet wire wound in two layers on an iron core formed of a bundle of soft iron wires half-inch in diameter and four inches in length. The secondary may be wound outside of the primary, and have the same number, turns, and layers of like wire. The condensers should be of mica, though paper ones will answer, and these should have a capacity of at least one microfarad each. Excellent results have also been obtained by using an ordinary telephone induction coil in connection with the condensers, and this I should advise the amateur to try.

Other Methods of Experiment

There are a large number of other ways of superposing the undulatory current from the transmitter on the direct current operating the arc. As an illustration, another ample and exceedingly effective method of connecting a transmitter taking a low voltage to a higher voltage arc lamp is shown in the diagram Fig. 3. In this case an impedance coil I

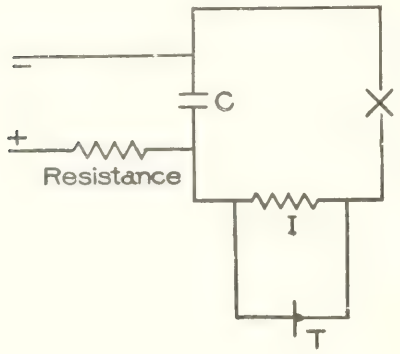


FIG. 3.

is connected in series with the arc lamp X; shunted around the impedance coil is an ordinary telephone transmitter T, while the lamp X and the coil are shunted by a condenser C. The condenser, which is due to Snyder, adds materially to the results. No battery, of course, is needed in this arrangement, for the current required for the transmitter is derived from the main circuit, and the current is an integral part of that of the generator.

There are several interesting experiments that can be performed with a speaking arc; but nearly all of them require more or less apparatus, though little if any that cannot be made by the amateur who has made things electrical. As an example it may be cited that when a Wehnelt electrolytic interrupter, or other type of high-frequency apparatus capable of making and breaking a 110-volt circuit, is connected to the mains which feed the arc, a curious phenomenon takes place.

Now, even though the interrupter and the arc light are separated a distance of several hundred feet, the arc will reproduce the sounds of the make and break nearly as loud as though the interrupter were immediately at hand. The sound of a dynamo in operation, often heard when one passes in close proximity to an ordinary arc, is caused by the passing of the segments of the commutator under the brushes of the generator.

By placing an adjustable capacity and variable inductance in shunt with the arc, it may be made to whistle; and again, if the inductance and capacity are varied in the proper proportions, the arc may be made to give forth a whole octave of notes, when it is known as a "musical arc."

It is difficult to make an alterating-current arc reproduce clear and undefiled articulate speech, and wherever this has been attempted musical tones like those of a jew's-harp are intermingled with those of the voice, producing a weird effect.

Dinner-Pail Philosophy

¶ Money can be lost in more ways than won.

¶ Blood is not much thicker than water when money is at stake.

¶ When a man is a sneak all through, he knows it, and the fact that he knows it makes him a sneak all through.

¶ Never look for truth on a tombstone.

¶ Man's christianity to man makes countless thousands mourn.

¶ Every man pays for what he gets in some kind of coin.

¶ In rare families as in rare books the editions are limited.

Told by Finger-Prints

Bertillon, Great French Expert, Tells How He Identifies Any One Criminal out of 200,000 Examined

By WILLIAM G. FITZ-GERALD

Author of "Round the World" and "Travel and Exploration in Central Australia"

"I HAVE the description cards of more than 200,000 criminals filed away here, but, in spite of their great number, I will guarantee to positively identify, by their use, any man who has ever passed through my hands, and I will do the work within five minutes."

It was Dr. Alphonse Bertillon, the great French expert, who spoke. He was standing in his private office, at the end of the long suite of rooms in the Paris Palace of Justice, which is given up to the Bureau of Identification. The floor of the office was marked out with chalk lines, as if some one had been drawing geometric diagrams on a large scale. Rising from the floor at regular intervals stood tall rules and measuring rods, like those used by surveyors.

Bertillon Tall and Thin

The man who has done more than anyone else to make hard the way of the modern criminal, is tallish, thin, and enthusiastic in manner, looking more like a student than one of the greatest of living criminologists. He walked back into a long room lighted by skylights and half filled with cabinets of drawers running from floor to ceiling. Between each pair of cabinets stood a small desk, occupied by an assistant in a long brown linen blouse.

CAMERA AND ACCESSORIES WITH WHICH DR. BERTILLON PHOTOGRAPHS CRIMINALS.

"In these drawers," said Dr. Bertillon, "we keep our records. And now, if you please, I will explain the system which makes it so easy to find among all these thousands, the card of the one man wanted.

"We have, let us say, 300,000 different cards in our files, when a criminal whom the police do not recognize is brought in to us to be identified. First of all we measure the length of the suspect's head, from the center of the forehead back. On the basis of this measurement alone we divide men—and our record cards—into three classes, viz.:

1. Small, length of head not greater than 7.24 inches.

2. Average, length of head from 7.25 to 7.48 inches.

3. Large, length of head 7.49 inches or more.

"At once, then, when this measurement is taken, we have eliminated, theoretically, at least, two-thirds of the cards, leaving only 100,000 to be considered.

"Next I measure the breadth of the head from side to side, classifying men and cards, again, into three groups, according to whether this measurement is small, average, or large. By this time I have only 33,000 cards left in which to look for my man.

RECORD CARDS.

Specimen of one of the "fiches" by means of which Dr. Bertillon identifies "Old Offenders."

Measure Face and Fingers

"The next division is according to the length of the middle finger, leaving 11,000 cards. Further subdivisions, based on the length of the forearm and the

breadth of face across the cheekbone, bring the number down to some 1,300.

"At this point I take advantage of a comparatively new and extremely interesting addition to the system. It is that of finger prints.

"When a criminal is brought to us for record we require him to ink the balls of each of the fingers on his left hand, by pressing them one at a time on a plate of copper, covered with a thin coat of printer's ink. He then presses each finger in turn on his record card, in a vacant space left for the purpose at the bottom, and thus leaves a permanent imprint.

Finger Prints a Test

"These imprints show the design of the lines on the skin of the fingers. They are of infinitely varied form and arrangement, and differ in practically every individual. At the same time they can all be classified into four different groups, viz:

1. Skin showing loops directed towards outside edge.

2. Oblique furrows towards inside edge.

3. Oval, circular, spiral, or volute furrows.

4. Arches and other furrows not included under previous headings.

"By classifying the remaining 1,300 cards, among which I must find the record card of the man under examination, on the basis of his finger prints, I am able to throw out all but about forty. There remains only to classify these forty on the basis of the subject's height and the length of his foot. By this time there are not likely to be more than five or six cards remaining, which can be looked over in detail and the proper card picked out."

No Chance of Error

"But is there no fear of error?"

"With so many indices it is almost impossible," he replied. "The finger prints taken alone might possibly mislead, but not when taken in conjunction with the measurements, and so I can say, infallibly, whether a man has been through my hands before. Two years ago I had a convincing proof of the value of finger-prints. A burglar broke into an office, killed the caretaker and robbed the safe. He had left his finger-prints marked on a pane of glass he had broken, and these I photographed. It took my staff some time to identify them, but at last I was able to declare that the prints were identical with those of an old convict named Schiffer. He was arrested and confessed the crime.

"Of course the finger-prints are of use only to aid us to recognize criminals who have been caught, but it struck me some years ago that I might utilize the photographs as aids in the recognition of old offenders who were "wanted" or suspected, or had returned after having been banished from the district or the country. I therefore prepared an album which included the photographs of 1,500 crimi-

METHOD OF PHOTOGRAPHING FROM ABOVE.
Picture shows the legs of the tripod on which the camera stands.

nals. That was by no means all, but that was the largest number the detectives could deal with comfortably.

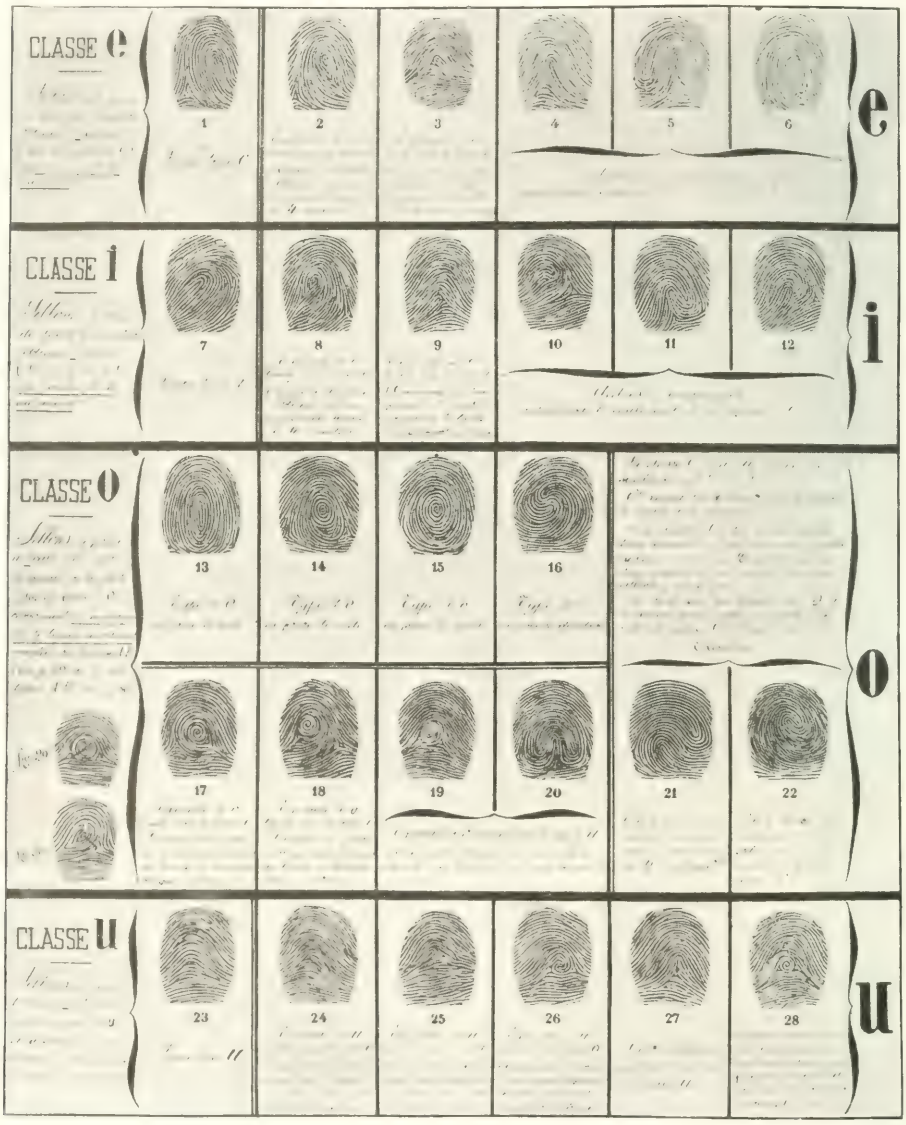
How to Remember Faces

"In fact it would be too much to expect that a police agent could remember 1,500 portraits—the large majority of them of men he had never seen—unless there was some method of aiding his memory. I therefore devised what I call "The Spoken Portrait." I chose, as the basis of the system the ear, which in its general conformation and in the shape of the lobe and the *tragus*, differs very much in different individuals. Besides, it can be studied without the owner's knowl-

edge, which is a great desideratum; for if a criminal—an escaped convict say,—saw a policeman staring at him full face, conscience and common sense would suggest a retreat and so put an end to the examination.

"Ears I divided into several classes; and the nose, forehead, and eyebrows were treated in the same way. The color of the eyes and hair and scars, if any, complete the description. The photographs in my album, though small, are clear and are arranged according to the system described.

"Nine years ago I first began by making experiments as to whether it would be possible to recognize a man from an oral description. I had a class of a dozen intelligent detectives and *gendarmes,* and I made them learn the outlines of the system, and then describe one another. Then I let half my class go amongst the prisoners awaiting examination—of whom there are always fifty or a hundred



CLASSIFIED FINGER-MARKS.

Dr. Bertillon has reduced to an exact science the identification of criminals by means of their finger-prints.

every day—and take mental notes of the appearance of some half dozen men.

"Having done this, they went into a room where my other pupils were, and made "spoken portraits" of the men they had peeked at. The others listened and were then required to go into the court-yard and find the persons described by their comrades.

"The men enjoyed the work, and used to make little bets amongst themselves as to who would first spot his man; and even the prisoners thought it a good game! Afterwards I used to take my class to one of the great prisons where there are several hundred convicts. Of course, the men reversed their parts and the describers one day were the finders the next. Usually, five out of six of the persons described would be found in from one to eight minutes, but the last would take nearly twenty minutes.

Prizes for Quickness

"I still keep my classes, and the last three years I have given prizes to the men who are quickest and surest at identifying. One detective who is exceptionally clever at the work, has arrested over 150 criminals whom he identified from their portraits in the album.

"So far I have spoken only of the identification of live men. Corpses are more difficult to recognize, and it not infrequently happens persons will swear to the identity of a corpse shown in the Morgue, and the supposed dead man will turn up alive and well a few days or weeks later. The bodies found in the river are often injured by bridges or boats, but the chief difficulty in the way of recognition is the fact that the eyes, which give vitality to the face are closed, or, if not closed, dull and sunken.

"Two Swiss surgeons, Drs. Cross and Reiss, obviate this by injecting glycerine into the chamber of the eye, which causes the eyeballs to enlarge and keeps the eyelids open. I employ this method and find it tolerably successful in giving an appearance of life. I am also careful to see that the head is exactly in the same position as it is carried in during life—that is to say, when a line drawn from the corner of the eye to the top of the *tragus* forms an angle of 15 degrees with a horizontal line across the plate. I have the two lines marked on the ground glass of the camera, and the body is placed on a couch, the back of which can be screwed up until the corpse is in the desired position.

"I think that completes the list of all I have done, except the work you now see me engaged upon."

What the Chalk Lines Mean

"May I venture to ask the nature of that work?" I said. "If there is no secret about them, I should be glad to learn the use of all these diagrams and measurements."

"There is no secret about them, but they belong to a different branch of my work, and concern not the detection of a crime, but the crime itself. You know that in France we attach great importance to the reconstruction of the scene of a crime or a suicide. This may be needful a long time after the crime or the accident, and when the body has been buried and the furniture, etc., disturbed. I always employ the same lens, and by means of these measurements and a scale applied to the edge of the photograph, I can tell the exact height, size, and distance from the camera, of every article in the room.

"A dead body I photograph three times. I first use the camera in the ordinary way; then I place the tripod across the body and photograph downwards; and finally I employ a camera which stands on the floor without any tripod and which my men call the "rat-trap." The rat-trap also comes in very useful for photographing a number of small articles standing on a table, such as medicine bottles or the remains of a meal.

"From these three photographs I can reproduce the scene of a drama so accurately that not even a pin shall be out of place. This, I think, completes the list of all I have done or have in hand at the moment."

INTERNATIONAL EXPERTS ON PANAMA CANAL.

ADVISE BY BOARD OF ENGINEERS OF THE ISTHMIAN CANAL COMMISSION, PHOTOGRAPHED AT THEIR FIRST MEETING IN WASHINGTON, SEPTEMBER 1, 1905.

Upper Row, left to right—Capt. Oakes, U. S. A., Secretary; Gen. Henry L. Abbott, U. S. A. (Retired), designed system of submarine mines adopted by U. S., designed harbor at Manitowoc, Wis.; Eugen Tincauser, Germany, consulting engineer of the great Kiel Canal; M. L. Quellenec, consulting engineer of Suez Canal; Isham Randolph, chief engineer Chicago Drainage Canal; Frederick B. Stearns, Boston, Mass.; Wm. H. Burr, professor of civil engineering at Columbia University, served for six years on Isthmian Canal Commission.

Lower Row—Joseph Ripley, engineer of Sault Ste. Marie Canal; Henry Hunter, Great Britain, consulting engineer of the Manchester Ship Canal; Adolphe Guerard, France; J. W. Welker, Netherlands; Alfred Noble, chief engineer Pennsylvania Railroad; Gen. George W. Davis, U. S. A. (Retired), assistant engineer Washington Monument, commanded military division of the Philippines, 1902; Wm. Barclay Parsons, chief engineer Rapid Transit Commission of New York.

Life Stories of Successful Men

JOHN F. STEVENS

Chief Engineer of the Panama Canal

By HENRY M. HYDE

TAKE a down east Yankee boy of twenty, with a square jaw, broad shoulders, and a tall muscular figure; convey him straight from his father's farm in Maine to the streets of a pioneer Western city, and turn him loose with a chain and tripod, under competent direction, to lay out building lines and locate boundaries; give him books, paper, lead-pencils, and the determination to master engineering problems for himself; season him with thirty years of strenuous service in the wild, savage, and inclement Northwest; let him fight with and conquer Indians, mountains, blizzards, and glaciers; put over him the gray old spider of world transportation, who uses thousand-mile railroad lines as the strands of his web, and who thinks in terms of continents; raise him gradually to the position of manager of a great transcontinental railroad system, with the work of thousands of men under his control; keep him filled always with energy, love of work, and patriotic feeling.

There you have the receipt for the making of an ideal chief engineer for the Panama canal—and at the same time a summary of the career of John F. Stevens, whom President Roosevelt has appointed to the post.

Stevens Gets Started

In 1873 Captain Jesse Stevens was a civil engineer at Lewiston, Me. At about the same time people out in the new town of Minneapolis were worrying about the probable destruction of St. Anthony's Falls, on the power from which the industries of the city were largely dependent. The rock over which the falls run is a white sandstone, which is easily and quite rapidly worn away by the action of the water. There was danger that in time it might be altogether worn away and the falls reduced to a mere rapid. Captain Stevens was sent for to see what could be done to permanently protect the crest of the falls from erosion. He succeeded in putting an apron on the falls—a heavy wooden cap over the soft stone. That work done, he settled down in Minneapolis, and presently sent for his young nephew, John F. Stevens, to come out and grow up with the country.

Stevens went promptly and, through the influence of his uncle, at once got a minor place in the engineering department of the city. The next two or three years were as important as any which followed in marking the career of the young engineer, for they were spent in hard study after working hours were over.

Catches the Eye of J. J. Hill

The energy, enthusiasm, and skill of John Stevens presently attracted the attention of James J. Hill, who was then just beginning to stretch his long arm out towards the Pacific. He wanted a railroad laid out from Minneapolis through the unexplored and wild country of the far Northwest. Stevens was sent out to do the locating. It was a task to test all the courage and all the resources of any man. John Stevens made friends with the Indians and got them to lead him over their trails through the otherwise practically unscratched country. As a rule these trails followed the easiest grades and marked the best and least costly path for a railroad. When the party was miles away from civilization something frightened the guides, and one night all the Indians disappeared, leaving the engineer to find his way through as

best he could. He succeeded. The path of the proposed road led through the mountains. With the aid of other Indians, Stevens found a pass which made most of the way comparatively easy. It is still called Stevens Pass. Then he came to a place where it seemed absolutely necessary to tunnel through a mountain. Stevens did not hesitate. When it came time to build the road, he started work at the same time on both sides of the cliff, and the bore met at the center exactly as he had planned.

Whipped the President's Son

"Yim Hell," as the Norwegian settlers of the northwest call the master of the Great Northern, knows a man when he meets one, and from the day John Stevens successfully completed the construction of that tunnel he became one of Hill's most trusted lieutenants. Before he was thirty he was made chief engineer of the western division of the Great Northern, in which most of the hardest engineering problems had to be faced.

It was on one of these surveying expeditions into the wild mountain country that a personal difference arose between the engineer in charge and the son of a great railroad president, who was a member of the party. As a matter of discipline Mr. Stevens finally found it necessary to soundly thrash the scion of transportation royalty, which he did with great thoroughness and dispatch. When the party got back again to headquarters the railroad president listened to his son's tale of complaint. Then he smiled grimly and said: "Stevens was right."

From 1879 to 1890 Mr. Stevens served as assistant engineer on various important western roads, such as the Denver & Rio Grande and the Canadian Pacific, spending most of the time in the field in personal charge of difficult engineering operations. In the latter year Mr. Hill, who knew what Stevens could do, brought him back to the Great Northern as Assistant Chief Engineer. Five years later he was put in complete charge of the engineering on the Great Northern system. Three years later Mr. Stevens resigned and spent a year as a railroad contractor, only to come back again to the Hill lines as chief engineer. In 1902 he was made General Manager of the Great Northern, continuing at the same time his duties as head of the engineering department. From that post he went to the Rock Island system, as chief engineer, rising later to become Second Vice President and General Manager.

Ready for a Great Work

When the President and Secretary Taft began to look about for an expert on railroad construction and management, who might act as adviser and executive for the Government in the building of railroads in the Philippines, they were told that John Stevens was the man of all for that work. Being both ambitious and patriotic, Stevens did not hesitate when it was pointed out to him that here was a great work to be done for his country and that he was the man who could do it. He had recently established his family in a handsome home on the Lake Shore Drive in Chicago, and had won—at the age of fifty-two—a splendid reputation as a master of transportation and construction problems. He had a right, perhaps, to expect that his days of strenuous adventure and of personal danger in the practice of his profession were over. But, because he loves to attack great and difficult problems, and because he is a patriotic American, he resigned his post and got ready to go to the Far East. Then came the Wallace resignation and the call that he should go to Panama, instead. He asked for forty-eight hours in which to consult his wife before making a decision. At the end of that time he was ready. From the Isthmus have already come stories of the impetus which he has given to the great work.

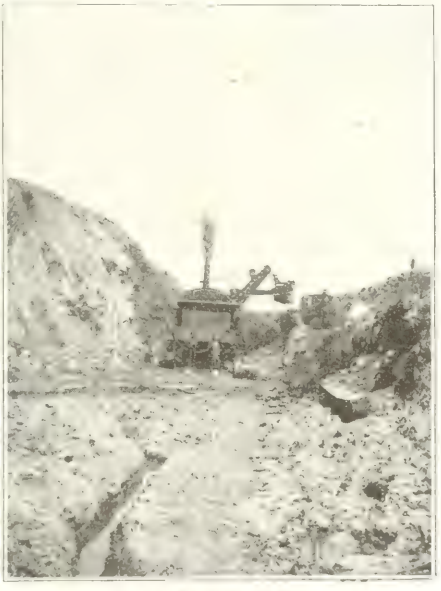
"The headquarters of construction work on the big ditch," says one of his old associates, "will be found under John Stevens's hat, and that you'll always find somewhere about the center of the firing line."

Steam Shovels in Railroad Work

Vast Earthwork Operations in California Involving Special Methods and Machinery

By J. MAYNE BALTIMORE

IN all railway construction work where cuts and fills are necessary, steam shovels and dump cars are indispensable auxiliaries. Wherever the nature of the soil permits, the former factors have almost entirely superseded the old-time pick and shovel; while the huge and capacious dump cars have taken the place of the primitive wheelbarrow. Only where the abundance of rock prevents operations with the giant steam shovel, do contractors have to fall back to the old and slower process of human labor.



STEAM SHOVEL AT WORK.

The difference in speed between a great steam shovel and even a large gang of men working with picks and shovels, is almost incredible; and the same may with truth be said of the modern trains of dump cars as compared with wheelbarrows and small hand cars.

Out west — especially in California — there is much activity in the way of railway construction; hence the giant steam shovels and their logical concomitant, the dump cars, are in abundant evidence.

One of the heaviest pieces of construction is known as the Bay Shore Cut-Off, and is being done by the Southern Pacific System. Though this cut-off is but a very short stretch of work—being only about fourteen miles in length—yet it represents one of the heaviest and most difficult (in an engineering sense) pieces of construction in the railroad history of the entire Pacific Coast, when the length of the road is considered.

There are four long tunnels to bore—one 1,100 feet, one 3,600 feet, another 2,640 feet, and a fourth 900 feet in length. Besides, there are many long and deep fills to make, one in particular being 5,700 feet long. Then there are some very heavy side cuts. Most of the heavy fills are sandwiched between the cuts and tunnels, which is a fortunate circumstance for the contractors.

Everything considered, it is an immense piece of railroad work, and the engineers estimate that two years will be required to construct even this short stretch of road. The cost will be immense to the company, running away up into the millions. This cut-off is being built for two reasons—first, to shorten distance, and second, to get a better grade.

About midway of the distance, will undoubtedly be the largest open railway cut in the United States, if not in the world. It will be, when completed, 1,315 feet long, 300 feet wide at the top, 40 feet at the tracks, and, at the highest

CABLE DRUM AND OPERATOR WORKING BALANCING BRAKE.

point about 150 feet deep—simply a stupendous piece of excavation. For several reasons the engineers considered it cheaper to make an open cut instead of tunneling.

Work on this gigantic cut has been in active progress for months. There are 5 powerful steam shovels tearing away day and night. Thousands of tons of stone and earth are removed every 24 hours, yet the work has scarcely commenced. A number of trains of dump cars are kept very busy carrying the shattered masses down the steep incline on each side and pouring them into deep, long, hungry fills. This cut is being made through rock, yet it is so soft that the shovels have but little difficulty in tearing a way through the embankments.

Mr. Henry A. Whitely, a well-known railway contractor of San Francisco, was awarded the herculean task of making this mighty open cut.

He has devised a somewhat novel method of operating the various dump trains working in connection with his great shovels. These cars are operated on the "compensating principle." By this is meant that the loaded trains are lowered down the steep grade to the fills by a smaller train acting as a balancing force. In the same manner are the empty trains pulled up the grade to where the shovels are in operation.

Operation of the Dump Cars

A long track has been laid running down the steep hillside. This grade is very sharp. On this track are placed five cars heavily loaded with rock, which are never unloaded. Attached to this train is a strong steel cable that passes around a large grooved iron pulley securely anchored at the top of the hill near where the shovels are operating. One end of this cable is wound around a large iron drum, or huge spool. This drum is double. Around the other end is wound a similar cable—running in an opposite direction.

Now, when a train of cars is ready to be lowered, a powerful steel hook is attached to the last car. The loaded train consists of six cars, and is much heavier than the five "balancing" cars. When the loaded train starts down and begins to unwind the cable, the drum at the opposite end winds up and pulls the balancing train slowly along the very sharp incline.

Of course the descending train is much heavier than the ascending one, though the grade of the latter's track is

LOADED TRAIN DESCENDING TO DUMP.

much sharper. But strong band brakes pass around each end of the big cable drum and are attached to a long and powerful lever. This lever is manipulated by an experienced brakeman. By a little pressure on the end of the lever, the speed may be regulated to a nicety. The cables are unwound and wound at the same instant. A little harder pressure stops the drum and the opposite moving trains in an instant. At all times everything is under the complete control of the man at the lever.

When the loaded train reaches the bottom, it is unhooked from the cable, another cable attached to a donkey engine is hitched on, and it is drawn out and dumped at the desired point. The hook of the other cable is attached to an empty waiting train, and, at a signal, the brakeman loosens his lever and gravity does the rest. The loaded cars move smoothly down the sharp grade and the empties are drawn to the top. When level ground is reached, they are detached from the cable and teams draw them up to where the great shovels are tearing out tons every few seconds. Here they are speedily reloaded, two big buckets usually filling one car.

So this balancing, compensating method of lowering and drawing up the trains goes on swiftly and ceaselessly. Hundreds of trains are easily and safely handled every 24 hours. It is much easier and faster than the old method of lowering and drawing up the dump trains by steam and machinery. Besides, it is much cheaper. There is no jarring and jerking. Whatever difference exists between the weight of ascending and descending trains is perfectly balanced and adjusted by the man working the lever.

This compensating principle was devised and applied by Mr. Whitely and has been found to work most effectively. No accident has ever occurred. This stupendous open cut involves the removal of more than one million cubic yards.

Mr. Whitely did the immense work for the Southern Pacific Railroad of filling in Mission Bay, in San Francisco. This task required many months to complete, and was only recently finished. In the prosecution of that work, the same compensating method was used until the work had nearly reached the required grade. The contractor found that the employment of gravitation to take the place of steam proved to be an economical method, and very successful.

"Balancing Cars" Mounting the Grade.

Mr. Whitely has also devised a method by which his giant shovels, when working on very steep grades, or at the edge of embankments, are placed on temporary trestles. Sometimes these trestles are 25 feet high—especially on the lower side—in order to keep the shovels perfectly level. These are noteworthy innovations in the methods of operating that mighty factor and friend of the railway contractor—the modern steam shovel.

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Articles Solicited

Illustrated articles on topics of timely interest are solicited for publication. Those that are *short* and *accompanied with good photographs* will receive special attention. Accepted articles will be paid for at regular space rates. Send photographs *flat, not rolled*, and inclose return postage.

¶ A man may be measured by the things he seeks.

¶ It is easy to mistake gas works for good works.

¶ Some men work overtime trying to dodge hard work.

¶ He can bear a great trust who can bear little trials.

¶ The smaller a man's mind, the longer it takes him to make it up.

¶ The seven ages of man: Baby, Willie, Will, William, Billie, Bill, Old Bill.

¶ Many try to drown their troubles in drink; but trouble is a good swimmer.

¶ Because a man is polite to you, don't presume that his time is without value.

¶ Many a man who takes a "horn" finds himself coming out at the small end.

¶ Concentration doesn't mean straining. It means cutting out the things that interfere.

¶ Courtship is a gas balloon that lifts a man heavenward, and marriage is a parachute that enables him to visit the earth again.

Is Everything Alive

"THIS razor is tired," says the barber. "It pulls. I'll lay it away and give it a chance to get rested."

You smile at the superstition, but it may well be that the barber is expressing one phase of a universal truth. Perhaps the razor is alive; perhaps it really does feel tired and overworked and enjoys a chance to rest.

Chundra Bose, an East Indian physicist of high reputation among scientific men, has detected in tin and other metals all the phenomena of fatigue and repose. M. von Schron, Director of the Pathological Institute of the University of Naples, has taken thousands of photographs of cells which form when a salt crystallizes out of a solution and he has observed what appears to be a struggle for existence among these cells. Huxley, Tyndall, a whole great school of eminent thinkers and scientists, have advanced the idea of hylozoism—of universal life. They believe that there is no such thing as dead or inanimate matter—that all matter is to some extent and in some degree alive.

"Life is self-movement," said Thomas Aquinas. To this definition the believer in hylozoism bows and adds: "And the whole universe is a perpetual motion machine, from the planets which ceaselessly circle in their courses, to the atoms of radium which display such terrific and continuous energy."

No one has yet drawn a distinction which will stand between live and so-called dead matter.

Age of the Sun

THE age of the sun has been for many years a matter of controversy between geologists and physicists. The investigators of tidal friction claim that 500 or 1,000 million years have elapsed since the birth of the moon; and other scientists, arguing from purely geological reasons, claim the age of the sun to be between 50 and 1,000 million years. On the other hand, it is asserted by physicists that, at the rate at which the sun is emitting energy, it cannot have been active for more than 20 million years.

A solution of this discrepancy has been

recently suggested by Prof. G. H. Darwin, president of the Association for the Advancement of Science, in his presidential address at the recent meeting of that body in Johannesburg, South Africa. He claims that the discovery of radium explains the difference in these estimates, because it has been shown that concentration of matter is not the only source from which the sun may draw its heat. There is every possibility that radium exists in the sun, and its energy will be more readily appreciated when it is considered that, while it requires from 5,000 to 6,000 tons of coal to propel a 12,000-ton ship 6,000 miles at the rate of 15 miles an hour, the same amount of energy is contained in 22 ounces of radium.

Turning on Cold in the Kitchen

NOT yet can the busy housewife turn on the cold in her refrigerator by twisting the same switch which controls the electric lights, but that is only because inventors have so far failed to put on the market an electric refrigerating plant of small enough capacity. The principle is well established and it has been demonstrated that a one-horse-power plant can be operated at a cost nearly fifty per cent less than the price of the 800 pounds of ice daily, which is its equivalent in refrigerating power.

Everybody knows that the ice box now in general use is a nuisance and, under many circumstances, a positive menace to health. If it is to be kept in a sanitary condition, it requires constant and careful attention. The announcement is therefore of universal importance, that electrical engineers have already demonstrated the fact that in any town where the cost of electric current is not more than five cents per kilowatt-hour, electricity will do the work of ice far more cheaply and that with no more attention than is required by the incandescent lights.

The man who first patents and puts on the market a plant which can be connected with the ordinary current that enters the house for electric lighting, and which will produce refrigeration equal to one hundred pounds of ice per day, will surely reap a financial reward greater than that of the inventor who perfected the telephone.

People in Glass Houses

MODERN science makes many old proverbs foolish. It was because he looked upon glass as the most fragile and brittle of human products that a wise man, years ago, set down his proverbial conviction that it would be well for people who live in glass houses not to throw stones.

Now it appears well within the bounds of possibility that glass walls may be used in the construction of buildings, and that people who live in them may throw all the stones they please without danger of having their own dwellings demolished in return.

Already glass railroad ties have been made, which are at once cheap and decay-proof. In the building of wharves, glass piles have been used and are found to far surpass wood, being entirely impervious to rot and at the same time resisting the attacks of the teredo, which so soon ruins wooden piles by boring them full of holes.

The coming of the glass house seems to depend chiefly on the development of cheaper power and improved methods of manufacture.

Importance of Irrigation

THE importance of irrigation in the United States can be judged by the fact that there are in the neighborhood of one million square miles of land within its boundaries, either entirely or partly dependent on an artificial supply of water; and while considerable has been done in this direction by private companies, a vast work of reclamation by irrigation is now being undertaken by the United States Government. One of the greatest of these government works—that at Salt River, Arizona—is described

on another page by Mr. Crittenden Marriott of the U. S. Geological Survey.

It is of interest to notice that the practice of irrigation is very ancient, reaching back, in the United States, to prehistoric times. There are to be found in various places in the West remains of irrigating canals far removed from any water supply, the rivers from which they obtained their water having either entirely disappeared or changed their courses. One benefit, however, remains from this prehistoric work, which is that many of the localities in the neighborhood of these ancient canals have been prepared and leveled for irrigation.

The cost of bringing water to the arid land in cases of private enterprises has averaged about $8.15 per acre, although in some parts of California it reaches $13.00 per acre. The average annual rental for water is a little over $1.00 per acre, although this varies considerably in different parts of the country. The value of irrigation to the crops is dependent both on the quantity of the water and the experience of the farmer in using it. Excessive use of water at the wrong time has often proved ruinous to crops, and in some cases the use of alkaline water has been equally injurious. One of the largest private irrigation enterprises in this country was at first a failure, due to the quantity of the alkali in the water, and a very large expense was incurred in diverting the alkaline stream from the reservoir, the system then becoming entirely successful.

Do Eclipse Expeditions Pay?

ASTRONOMERS are no better prognosticators of the weather than the weather prophets themselves. The best-laid plans of eclipse expeditions are frequently rendered futile by a tiny patch of cloud scarcely larger than a man's hand. The failure of both the Canadian and the Lick Observatory parties in the Labrador peninsula to catch even a glimpse of the corona of August 30, raises again the question as to whether these costly expeditions pay. Could not the money be used to greater advantage, even from the astronomical point of view, in the equipment of permanent observatories?

To this question comes the inevitable answer that the term "paying" does not apply in the case of scientific research. "Know for the sake of knowing" is the scientist's motto; and a utilitarian forecasting of tangible results would be as foreign to his spirit as a tropical lily to the North Pole. Who can tell what the results will be, anyway? What advance could be made if all effort were to be reduced to this standard? How many pioneers who blazed the way to scientific achievement have reaped the pecuniary benefits they rendered possible? Count them up, and they are few.

Adequately to compass the eclipse problem requires that all possible stations shall be occupied. The chances of unpropitious weather afford no absolution from this duty. In 1896, for example, had expeditions been sent to two apparently hopeless points—Nova Zembla, and Bodö, in Norway—they would have reaped results denied all other observers along the track of totality. A similar chance was lost in 1886 on the west coast of Africa, while effort was wasted in the West Indies. But again, in 1889, West Africa proved as deceptive, and as indifferent to human longings, as has Labrador this year.

Scientific work at best is, in general, an evolution of disappointments and puzzles. The one who shrinks before the possibility of failure has worse than failed already, for the scientific spirit is no part of his make-up. Even to an eclipse party, failure to see an eclipse is not the direst thing that could happen. To think "the game not worth the candle" would be something far worse, for the rise of such a thought would proclaim the passing of the scientific spirit—the crystallization of our scientific knowledge into a body as devoid of inner vitality, and as incapable of further development, as the fossilized and dusty civilization of the Chinese. The advance of science in the future, as in the past, will be through willingness to sacrifice—to cast bread upon the waters in the faith of an unknown return.

Strange Fluor-Spar Mine

Thousands of Tons of Rare Mineral Dug from the Earth at Fairview, Illinois

By MALCOLM McDOWELL

Staff Correspondent, TECHNICAL WORLD MAGAZINE

THE shaft top of one of the most interesting mines in this country peers over the trees which crest the high bluffs lining the Illinois side of the Ohio river, and looks across the placid waters to Kentucky's green meadows. Hundreds of feet below, men are moleing their slow way through solid crystal, for this is John Mulholland's

FAIRVIEW FLUOR-SPAR MILL.

fluor-spar mine at Fairview, fifteen miles above Golconda, Illinois.

Some distance river-ward are freight cars filling with the crushed spar still damp from the water which carried it through the washers, crushers, and jigs that put this most cleansing of all fluxes into shape for the steel furnaces for which it is destined. Thousands of tons of this fluor-spar are dug from this mine and shipped to steel and iron works, potteries, tile factories, glass works, and hydrofluoric acid manufactories; and yet a ridiculously large number of people do not even know what fluor-spar is.

Composition and Color of Fluor-Spar

Ask a mineralogist what fluor-spar is, and he will reply, "Fluorine is an element related to both chlorine and oxygen. When it combines with calcium it forms fluoride of calcium, and that is fluor-spar." He also may go on to explain that fluor-spar frequently is beautifully colored, and this bit of information is confirmed in a striking degree to any one who is so fortunate as to be lowered through the narrow shaft three hundred feet to the bottom of the Fairview mine. Incandescent electric lights illumine the lower levels and when the glowing bulb sends its rays against the roof and walls of the tunnel it discloses soft purples, bright greens, warm browns, and cheerful yellows, the colors seeming to flame out as if the excavation had been cut through an immense opal.

When white men first pierced the forests of the Ohio river valley, they came across Indians whose arrow heads were fashioned from a curious stone, lavender, purple, and yellow. The aborigines were decked out with charms and necklaces made of the same stone and some of the jewelry had shining bits of cube lead set in the crystals. These arrow heads and charms were made from the fluor-spar which lay on the surface all over that country adjacent to the Fairview mines.

Mines First Worked for Lead

Over a quarter of a century ago the mineral deposits there were worked for

LOADING FLUOR-SPAR INTO CARS.

the lead, for then the owners of the properties did not know that the refuse they threw away was worth to them more than the lead from which it had been separated. To-day the lead, for five per cent of the stuff brought to the surface is cube lead, practically pays the expenses of operating the mine and mill. And mixed with the calcium-fluoride also are gold, silver, and copper, but in such small quantities that they are set down in the assayer's daily report as "traces."

The fluor-spar lies in true fissure veins of undoubted volcanic origin. The hanging wall is limestone and slate, the foot wall is calc. Between the two walls, which are from eighteen to thirty and more feet apart, is the spar. One vein, the Good Hope, is over three miles long and apparently dips down to the very center of the earth. Its depth has never been fathomed. The Anderson Well vein is much shorter than the Good Hope, and the Blue Diggings has never been worked. The lowest level of the Good Hope vein is down some three hundred feet and the mine apparently is inexhaustible.

No Dirt or Gas in this Mine

The shaft, but little larger than the cylindrical steel skip used for transporting the spar and miners, descends on a decided slant to the working levels; and the man with patent leather shoes need have no fear of soiling them by going down into the mine, for no dirt, muck, or clay is found in th' crystallized bore. The water is clear, for there is nothing to discolor it. The air drills, boring holes for the blasts, send bell-like vibrations through the subterranean galleries, for the steel cutters are continually pounding into solid, glass-like mineral. The air, though warm, is sweet, for there are no carbonized gases to peril the lives of the miners.

In many ways the mining and milling of fluor-spar and gold are identical. In the processes which follow the delivery of the material to the mill, there is but little lost—the bulk of the broken mineral which comes to the surface is shipped. It is only such parts of the walls as are brought out that are sent to the dump. To prepare fluor-spar for the several purposes for which it is used in the industrial arts, it is necessary to grind some of it, the purest, into a flour-like powder, to separate and save the lead and to throw out the calc. All this is done in the mill, which is part of the shaft top.

Men and Boys Pick out the Pure Spar

The ore—for, after all, this material is a lead ore—is dumped from the skip into a washer which delivers it all upon a slowly moving "picking" belt. Men and boys line this belt, and their deft fingers pick out the calc and other rubbish, the pure spar and the spar having lead in it. Each sorting is thrown into a chute which conveys the material to the several parts of the mill where it receives its proper treatment. The pure stuff, known as No. 1 spar, is clear white, and cannot be mistaken for any other grade. From the picking belt it goes straight to a crusher where the big lumps are broken to smaller bits, and then it is elevated to a sheet-iron platform heated by steam, over which it is spread by a boy who shoves the stuff back from the chute to the far end of the steam table.

Before its slow but short journey is finished, the wet spar is dried and ready

WHERE FLUOR-SPAR MINERS LIVE.

for the Griffen grinding mill, which turns it into powder. It then is sifted, and all that cannot pass through the meshes of the bolting cloth is re-ground. The powdered spar afterwards is packed into barrels holding from 580 to 610 pounds of the powdered material This pure fluor-spar, purer than any spar imported from England or Germany, is sent to factories which make fine glass, enamel, tiles, and pottery, and carloads of it are turned into hydrofluoric acid. No. 1 spar runs over

99 per cent pure; that is, it contains over 99 per cent of calcium fluoride.

Used as Cleansing Agent in Steel Mills

Lump spar, another grade, is the beautifully colored, many-hued spar which embellishes the mine. After it is thrown off the picking belt, it is sent to bins and shipped without further treatment to steel and iron works. It is used in the making of steel and iron as a cleansing flux, an agent which cuts out the impurities that inimically affect those useful metals.

All the spar containing lead, first is run through a crusher and thence elevated into a bin. Automatic feeders send it through sets of rollers which disintegrate the lumps, crushing the spar and breaking it into bits the size of pebbles. In this form it is run through sets of jigs, which, by means of water and because of the difference of specific gravities, separate the spar from the lead—the spar being the lighter is thrown off at the top, the heavier lead at the bottom. Some of the material is handled five times, for not only is it a good thing to secure all the lead, but it is necessary to have the "tailings," known in the shop talk of the mill as "pebble spar," perfectly free from lead, for the pebble spar also is shipped to steel and iron mills. The lead is sent to a refinery to be made into the lead of commerce.

All Owned by John Mulholland

John Mulholland of New York, a man of gigantic frame, big heart, and permeated by that brand of optimism which enables him to successfully handle this fluor-spar property, a railroad in Texas, and a dozen other big enterprises, was confronted with several problems in the handling and shipping of his spar and the care of his employees. There is no railroad connecting Fairview with the outside world. Its nearest railroad gateway is the little town of Golconda, in the extreme southeastern part of Illinois. So this fluor-spar magnate ran a short spur from the railroad out of Golconda to a convenient point on the river bank, built an incline, made a similar incline at Fairview, built the swiftest tugboat which plies the Ohio river, and now ferries his freight cars between the mines and the railroad.

The matter of housing his people came up, and Mr. Mulholland sent for a

Fluor-Spar Car Ferry Across Ohio.

trainload of cement, dug clean sand from the river bottom, and is building a town on the heights near the mine out of concrete. Charles E. Turner, an official of the Fairview Fluor-Spar company, is regarded as the best posted man in the country on fluor-spar. He said:

"This deposit at Fairview is the largest known deposit of fluor-spar in the world, and the purest mineral is found here. The only explanation geologists have to offer to account for the unique outcropping of fluor-spar at this point, is that in the times when the earth was making geological history these fissures opened, the molten material gushed up, and when it cooled the gaps were filled with fluor-spar. There are other deposits found in this country, and we imported last year about 75,000 tons from England and other points in Europe, but nowhere on the face of the earth is found so much of the stuff as is at this place on the Ohio river."

How to Make Drills

An Explanation of the Processes of Making, Grinding, and Hardening the Types of Drills Most Used in the Machine Shop

By EDWARD R. MARKHAM

Instructor in Machine Shop Work, Rindge Manual Training School

THE forms of drills commonly used in the machine shop are the flat drill, single-lip drill, and twist drill. As it is usually cheaper and more satisfactory to buy twist drills than to make them, their manufacture will not be taken up in this discusssion.

Flat drills, intended for use in the engine lathe for chucking, are usually forged to shape in the forge shop. After centering the end, which rests on the tail center of the lathe, the lips are ground to shape and the drill is ready for use. A drill of this description is shown in Fig. 1.

If it is necessary to have the drill cut nearly exact to size, it should be forged

FIG. 1.

somewhat wider than finish size, and the edges turned in the lathe as in Fig. 2. The projection A must be left on the cutting end to provide a center for turning. If the drill is to be ground to size after hardening, the projection must be left on until the grinding has been done, but, ordinarily, this class of drill is not intended to cut exact enough to require grinding.

If the edges of the drill are not to be ground to size, they should be drawfiled a small amount, to avoid binding. The filing should not come within 1-64 inch of the edge, and should be only a small amount (.003 or .004 inch will be found sufficient); if given too much relief, the drill will jump and chatter. The shank should be somewhat smaller (1-32 to 1-16 inch) than the cutting end, in order not to touch the sides of a hole drilled deep enough for the shank to enter. The center in the shank end should be large, to insure a good bearing on the tail center of the lathe, as shown at A, Fig. 1.

FIG. 2.

When hardening, the drill should be heated a *low red* to a point above the cutting end, preferably about one-half the length of the portion turned smaller than the ends. When dipped in the bath it should be plunged about one inch above the cutting end. To insure good results it should be worked up and down and around in the bath, which may be either water or brine. The temper should be drawn to a brown color.

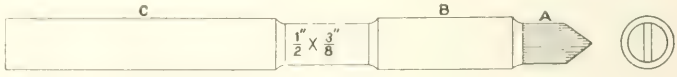


FIG. 3

When a flat drill is intended for use in a drill press, the shank is left round, in order that it may be held in a chuck or collet.

Transfer Drill

Another form of flat drill termed a

*From the Author's Instruction Paper on Tool Making, Part 1, written for the American School of Correspondence at Armour Institute of Technology.

transfer drill, is very useful when a small hole is to be transferred from a larger. The shank C, Fig. 3, may be made of any convenient size; the portion B is of the

Fig. 4.

size of the larger hole, while A is of the size of the hole to be transferred, and is a short *flat* drill.

When making this drill, if a lathe is used having draw-in split chucks, the drill may be made from drill rod, which should be enough larger than finish size to allow B to be turned, to insure its running true with A; the cutting part A may be milled or filed to thickness. The cutting lips are then backed off, and the drill hardened. It should be hardened high enough so that A and B are hard, as the portion A does the cutting, while

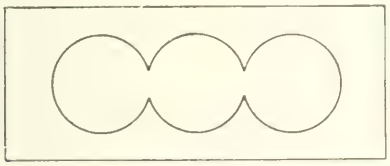


Fig. 5.

B, being a running fit in a hole, is likely to rough if it is soft.

To harden, it should be heated in a tube and dipped in water or brine, and worked up and down, to avoid soft spots caused by steam keeping the water from the metal, as sometimes happens when a piece has different sizes close together. The cutting portion A should be drawn to a deep straw color; B should be left as hard as possible, to resist wear.

Fluted Drills

Straightway, or straight fluted drills, have the flutes cut parallel to a plane passing through the axis of the drill, as shown in Fig. 4. They are used in drilling brass, and in drilling iron and steel when the holes break into one another, as shown in Fig. 5.

Smaller sizes may be made of drill rod. After cutting to length, the blank may be put in a chuck in the lathe and the end pointed to the proper cutting angle. When milling the flute, the shank may be held in the chuck on the end of the spiral head spindle. The head should be set at an angle that makes the flute deeper at the cutting end of the drill than at the shank end; this causes an increase of thickness at the shank, thus making the

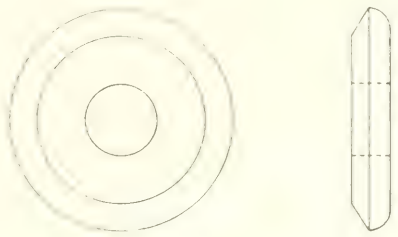


Fig. 6.

drill stronger than if the flute were of uniform depth throughout. The milling cutter should be of a shape that will make the cutting face of the drill a straight line when the drill is ground to the proper cutting angle. The corner should be somewhat rounded. The general shape of the cutter is shown in Fig. 6.

Single-Lip Drills

For certain classes of work, the single-lip drill is very useful. Having but one cutting edge, its action is similar to that of a boring tool used for inside turning in the engine lathe. The body of the drill being the size of the hole drilled, insures its cutting a straight hole, even when used in drilling work partly cut away, or castings having blow-holes or similar imperfections. It does not cut as rapidly as the other forms, consequently is not used where a twist drill

Fig. 7

would do satisfactory work. Fig. 7 shows a form of single-lip drill to be used with a bushing. The steel for this drill should be somewhat larger than finish size, in order that the decarbonized

surface may be removed; the cutting end A and the shank B should be turned .014 to .020 inch larger than finish diameter, to allow for grinding after the drill is hardened. The portion C should be turned to finish size and stamped. In order that the drill may be ground to size after it is hardened, it will be found

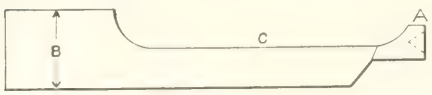


FIG. 8.

necessary to face the end back, leaving the projection containing the center as shown at A in Fig. 8. The cutting end should be milled to exactly one-half the diameter of B. After milling, the face C should be draw-filed until it is flat and smooth. When hardening, the drill should be slowly heated to a low red, a trifle higher than the portion that is to be cutting size; it should be plunged in a bath of warm water or warm brine, in order to avoid as far as possible any tendency to springing or cracking in the projection A. The tendency to crack is due to its peculiar shape and the difference in its size and that of the drill. After hardening, it may be drawn to a straw color.

When grinding, it is advisable to grind the shank first, in order that the grinding machine may be adjusted to grind straight; after grinding the shank and cutting end to size, the projection A may be ground off, and the cutting end given the required shape, as shown in Fig. 9.

When a single-lip drill is to be used on iron and steel and not upon brass, it may be made to cut more freely by giv-

FIG. 9.

ing the cutting-face rake, as shown in Fig. 10. This may be done by milling the portion A to the proper dimensions, which should be one-half the diameter of the blank. The end and sides of the drill may now be coated with the blue vitriol solution and the desired shape marked out, after which it may be placed in the milling machine vise at the proper angle, and the required amount of rake given by means of small end cutters. After giving the necessary end clearance as shown in the two views of Fig. 10, the drill is ready for hardening.

In order to adjust a drill of this kind to compensate for wear, it may be made as shown in Fig. 11, in which one-quarter of the circumference is cut away at A and a blade or cutter fastened in position; the top face of the cutter should be radial. To compensate for wear, pieces of paper or thin sheet metal may be inserted under the blade.

When cutting away the portion A, three holes may be drilled, as shown in Fig. 12. If square corners are desired, care should be taken that the holes are located so that they will machine out when milling to the proper dimensions. After drilling, the body of the drill may

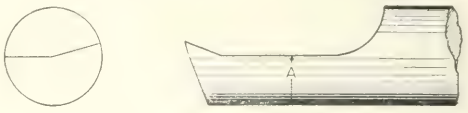


FIG. 10.

be placed in a vise in the shaper, and by the use of a cutting-off tool (parting tool) the portion may be removed; but, as it would be impossible to cut to finish dimensions, it will be necessary to finish with small end-milling cutters, holding the tool in the chuck on the spindle of the spiral head. After machining one surface, the spindle may be revolved one quarter-turn and the other surface machined; this insures square corners, and two surfaces at right angles to each other. The surface on which the cutter is to rest should be cut below the line of center, so that the top edge of cutter may be radial; that is, it should be cut the thickness of the cutter below a line passing through the center. See Fig. 11.

The cutter should be made of tool steel; two holes should be drilled for the fastening screws. After fastening the cutter in position, it may be turned to the proper diameter by running the body of the tool in the steady rest of the lathe.

Care should be used not to cut into the body or holder. After turning to size and facing the end square, the cutter

FIG. 11.

ance given to prevent binding; this may be done by removing a trifle more stock at the bottom than at the top edge. To

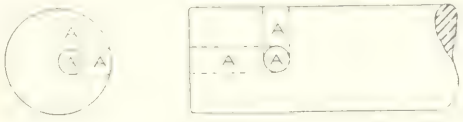


FIG. 12.

may be removed from the holder, and necessary clearance given the end by filing; the outer edge may be draw-filed in order to smooth it, and a slight clearharden, it should be heated to a low red heat and dipped in lukewarm water; the temper of the drill may be drawn to a straw color.

Making Round Cotton Bales

Method of Packing Southern Staple which will Save Millions to Planters

By DAY ALLEN WILLEY

DURING a good season, more than 10,000,000 bales of cotton are packed in the Southern States. Until recently the practice has been to press the cotton into square bales of 500 pounds each. This method of preparing the staple for shipment is costly and wasteful.

The more modern and economical package is the round bale, which has been quite generally adopted in parts of the Southwest. The press for the production of round bales weighs six tons, and occupies a floor space 4½ feet square, with an arm supporting the screw shaft extending laterally about six feet from the press proper. The cotton enters the top of the machine, passing between two belts operated on wooden rolls. The rolls and belts form a figure similar to the upper half of the letter Y, the lower ends of the trough formed

BALE BEFORE COMPRESSION.

BALE AFTER COMPRESSION.

OLD-STYLE COMPRESS FOR SQUARE BALE.

by them gradually contracting until but a few inches of space are left for the cotton to pass through.

By a movement somewhat like that of the carding machine in a spinning mill, it is carried up into the bale former, as it might be termed, which revolves around an adjustable steel core. The endless belt of heavy metallic links operates two steel baling rolls which travel on carriages. These rolls, revolved by the belt, act in connection with the bale former, holding the cotton in place, gradually moving backward on their carriages as the size of the bale increases. As the baling winds around the core, the operator exerts more pressure on the rolls by means of the chain. When the mass of cotton is ten inches in diameter, the pressure is 13 pounds to the square inch of its surface, the total pressure exerted being 7,500 pounds to the bale at the finish. When the roll has reached the required dimensions, the covering, which is suspended in a wooden framework above the press, is released, and, descending, is formed mechanically around the bale. The metal ties which have been adjusted to the cover before it enters the machine are fastened by what might be termed metallic fingers. The operator then lets down the front of the press; and the bale, ready for shipment, is rolled out. This press can be operated by six horse-power and will take the product of six cotton gins when operated at its maximum speed.

READY FOR A FIRE.
Square bales of cotton at boat landing.—View showing waste, deterioration, and danger under the old system.

This press is quite similar in appearance to the one used principally in the Southeastern and Gulf States, which

THROWING OUT WASTE COTTON FROM DAMAGED BALES.

ROLLING COTTON INTO BALES BY MACHINERY.
View showing pressing rolls.

turns out what is known as the American round-lap bale. It is also attached to a condenser and bat former, which take the place of the original condenser in the square-bale press. The plant is attached directly to a series of from two to six or more gins, the condenser being connected with what is known as the "lint flue," delivering the cotton as it comes from the gin to the bat former beneath it. The former comprises two endless aprons mounted in V shape, their inner surfaces traveling downward. The space between these is closed at both ends by boards, forming a hopper, which receives the loose cotton directly from the condenser, converting it into a bat of 10 to 12 inches in thickness and averaging 2¾ pounds in weight to the square yard. In a continuous roll the bat passes beneath the first compression roll, which excludes most of the air, while the compressed material is wound around a steel core. The core constitutes the temporary center of the bale, which is formed by the revolution of two baling or compression rolls and the baling belt which passes beneath the rolls and under the bat. The belt acts as a guide in keeping the bat of the proper dimensions, while it also keeps it from sagging down and rolling unevenly.

The baling rolls are located 5½ inches apart in this press, so that in the process the bat is wound several times around the core by the belt before encountering pressure from the rolls. But one roll is adjustable, moving back and forth. It is regulated by a valve connected with a compressed-air chamber and cylinder, allowing the pressman to exert whatever pressure is desired upon the exterior of the bale. The air in the chamber is com-

STITCHING COVER ON BALE.

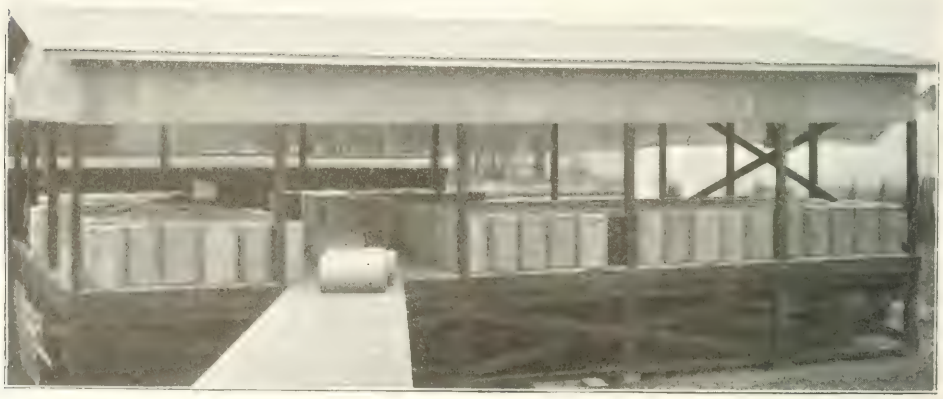
PUTTING COVER ON FINISHED BALE.

pressed by hydraulic power, the pressure varying from 325 to 275 pounds per square inch in the smaller presses, and from 250 to 200 pounds per square inch in the larger size.

The winding continues until the bale is of the proper diameter, when a signal bell is rung automatically and the bat it shifted to the opposite side of the press and a new bale begun. The completed bale is lifted from the bed of the press by the attendants, the core knocked out with a mallet, and its covering stitched on. It is then ready for the market, with the exception of stenciling the weight, the press from which it came, and the address.

The majority of the round-bale presses in use in the South have bale formers on each side, and are so arranged that two bales can be prepared at once, the condenser being large enough to supply the necessary double bat. They are of two sizes, one turning out smaller bales for export demand, and the other a large size for American mills. The time required for the entire operation varies from 8 to 20 minutes, according to the rate of speed of the machinery. When running at maximum speed, 10 minutes will cover all of the work, including the wrapping and labeling.

By the methods we have described, the staple is very thoroughly cleaned before it is packed, consequently the percentage of foreign matter found in a round bale is so small as to be insignificant. One of the most important features in favor of the round bale, however, is that it eliminates much of the danger of fire. Where pressure is applied to a mass of cotton from the outside merely, more or less air becomes



READY FOR THE MILL.
Bales rolled from treating plant to freight platform for shipment.

AIR-CURRENT DRAWING COTTON INTO GIN.

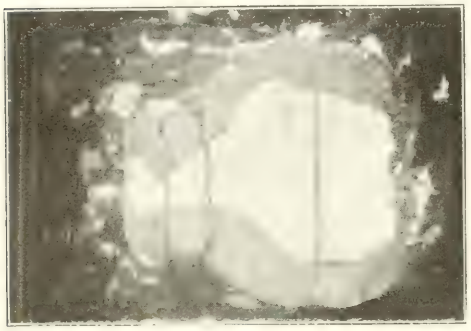
imprisoned in the bale. If the material accidentally ignites, the fire spreads with great rapidity. This is one reason why cotton fires as they have been called, have been attended with such disastrous results, because the bales are so inflammable. By rolling up a bale as is done in the round process, pressure is applied to the various portions, and the package is much more solid, consequently less liable to burn, while, being wrapped in a more closely woven cover, it can be handled with little danger of the covering being torn and the material exposed.

It is perhaps needless to say that a much larger quantity of the staple can be placed in a railroad car or the hull of a vessel, where the round bale is used. The density of the American square bale is from 20 to 25 pounds to the cubic foot. A car loaded with square bales 54 inches long, 27 inches wide, and 16 inches in

MODERN COTTON-TREATING PLANT.

Cotton is cleaned, ginned, pressed, and baled, and the seed converted into oil and meal, entirely by machinery.

thickness, will carry between 24,000 and 25,000 pounds. A cargo of bales pressed but once at the plantation, will average about 13,000 pounds. The same size cars loaded with round-bale cotton have carried from 52,000 to 79,000 pounds. The density in the round bale ranges from 35 to 50 pounds per cubic foot,



SQUARE BALE BURST OPEN THROUGH CARELESS WRAPPING.

which is the same density as that of Egyptian cotton, considered the best square bale in the world. It is calculated that the round bale can be stowed on board vessels with a loss of but 9¾ per cent in waste space, while the expense of screwing, which is necessary in loading square bales, is done away with, saving from 30 to 40 cents per bale.

The principal objection to the round-bale process is that the method by which the pressure is applied may crush the fiber; but, as already stated, the presses are equipped with gauges which accurately register the pressure applied, and such injury is not likely except by carelessness on the part of the operator.

All Done by Machinery

The accompanying photographs give an excellent illustration of the system by which cotton is prepared for market by the round-bale method. In the plant illustrated, the cotton is taken from wagons through receiving pipes by means of suction, and carried direct to the gins for separating the lint from the seed and cleaning it. Thence it is taken by endless conveyors or by suction to the press feeders, where it is gradually formed into a bat by the process already described. The only periods when it is touched by hand are in taking out a sample as the bale is being formed, lifting the completed bale from the press, and covering it. As the photographs show, no time is lost in conveying the packed cotton to the railroad car, as the tracks are by the side of the baling plant. Some of the baling stations in the South are operated in connection with cottonseed oil mills; and as soon as the seed is separated from the lint, it is taken mechanically to the mill to be crushed and resolved into the oil and "meal," which is utilized for fertilizer, stock feed, and a variety of other purposes.

The Man Worth While

IT'S easy enough to be pleasant
When life flows along like a song,
But the man worth while
Is the one who can smile
When everything goes dead wrong.

Things Common and Uncommon

By MALCOLM McDOWELL

Author of "Shop Talks" Editorial Staff, TECHNICAL WORLD MAGAZINE

MOST people think that asbestos is a manufactured product. Comparatively few know that the fireproof stuff which, in one form or another, is found in every shop and home is one of the most wonderful of the substances dug from the earth. Most of the asbestos used in this country comes from Canada. It is also found in some of the Rocky Mountain States and is mined in the Italian Alps. But except in Canada the veins of the greasy-feeling, silky-like fibrous stuff are too thin to be worked with profit, for the problem in mining asbestos is found in the disposition of the foreign matter in which the asbestos is entombed. In the Canadian mines only about four per cent of the material quarried is asbestos; the rest is made up of rock and other refuse.

Asbestos is found in veins which vary from half an inch to four inches thick, between layers of hornblende crystals. The deeper the digging, the longer and tougher are the asbestos fibers. Dynamite is used to blast out a layer, which falls to the floor of the mine. The miner breaks out as much of the pure asbestos and in as large lumps as possible, and sends the lumps to the surface, where boys and young men "cob" or crumble the rock away from the fibers. The asbestos, still in the lump form, is packed in coarse bags and shipped to this country to be made into finished products. As it comes from the mines, the asbestos is of a yellowish or greenish color, the edges furred with loose fiber. The best asbestos is a dirty white, and its fiber is long enough to be carded and spun into yarn and then woven into a fireproof, acid proof, and weatherproof cloth.

The lumps of raw asbestos are fed into a machine which crushes them until the fibers are loosened into fluffy cottony masses. From the crushing mill the stuff goes into a machine which separates the long and short fibers. The short fibers are ground into a pulp or powder according to the use for which they are intended, and the long fibers are gathered together to be woven into cloth. Combined with colors and oils, asbestos makes a paint which is fireproof or almost so. Mixed with wood pulp, it makes a heat-proof material suitable for covering steam pipes. Combined with canvas, felt, or like material, it makes an excellent roofing or ceiling material. Quantities of it are used for insulation, and asbestos is largely used for packing piston rods, valve stems, etc., filling the double office of packing and lubricant.

* * *

One would think it an extraordinary proceeding to shovel the mud and muck from a swamp under a boiler, touch a match to it, and raise steam without trouble or smoke. Yet that is practically what a number of manufacturers in Florida, Indiana, Manitoba, Illinois, and other places, where there are peat bogs, are doing. The fuel which figures so largely in the history and romance of Ireland is making its way to the front as a steam raiser in this country, and the steam user who has a peat bog within convenient distance of his boiler room is esteemed a fortunate man.

The peat is not used dripping wet as it comes from the swamp, but is put through a preparation process before it is qualified to pose as a steam raiser. In brief, the natural peat is reduced to a pulp, moulded into briquettes, and dried in the air a certain time before it becomes a fuel. The pulping and brick making are done by machinery, and some peat users have plants which handle the material from the moment it is placed in

the conveyor until the pressed bricks are discharged onto the drying floor, with but little manual assistance.

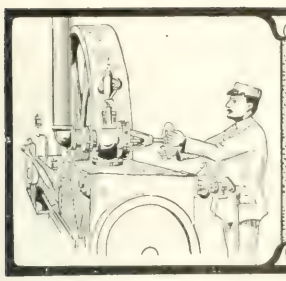
The peat machine consists of two parts, a condenser and a molding machine. In the condenser the peat is shredded by a cylinder with knife-like projections, and is further kneaded, rubbed, and disintegrated by other cylinders until it emerges from the condenser reduced in bulk fully a quarter. The peat is about the consistency of felt when it is fed into the briquette machine, which turns out about 125 bricks—or briquettes, as they are called—each 8 by 4 by 2½ inches in size. The peat bricks are carried to a level piece of ground where they are kept in the air and sun from 2 to 3 days until dry and stiff. If they are not to be shipped, they can be used without further drying. They burn well, making an intense heat without clinkers, smoke, or fumes. Those who have used peat for steaming purposes say it is a first-class steam raiser when properly handled.

* * *

Because electric telegrams are projected through the air without the aid of metallic conductors, enthusiastic extremists are heralding the approach of the "wireless age." As a matter of cold-blooded fact this is the age of wire, and every day finds the uses of metallic filaments extended. If all the telegraph and telephone lines and cables were made useless because of the wireless telegraph and telephone systems, the uses of wire in everything that pertains to our industrial, domestic, and scientific life would still be so manifold that it would be no wild fancy to say this is the age of wire.

Iron, steel, copper, aluminum, gold, silver, zinc, and other metals are drawn out into wire for thousands of common purposes. Wire enters into the making of clothing, hats, furniture, household necessities, and the scores of things which men and women carry around with them; it fences millions of acres of land and is the vital part of every watch; millions and millions of feet of wire are consumed in the making of ornaments and adornments for women's clothing alone; thousands of miles are strung in pianos; and an inconceivable amount is eaten up annually just for pins and needles. To attempt to estimate the weight and length of the wire that is consumed in the manufacture of rope, bale ties, barrel hoops, mattresses, gauze for fly screens, sieves, riddles, bird cages, nails, hooks and eyes, umbrella ribs, rivets, fish hooks, picture wire, carding machines, spectacle frames, watch springs, tacks, musical and scientific instruments, and gold and silver braid, would be merely to indulge in wild guesses.

Wire has been drawn so exquisitely fine that the human hair and the thread of the silkworm would be coarse in comparison. It is estimated that the human hair is about one five-hundredth inch in diameter, and the silkworm's filament is about one five-thousandth inch in diameter. Yet platinum wire has been drawn down to one twenty-five-thousandth inch in diameter. Aluminum wire has been drawn as fine as 11,400 yards to the ounce, and iron has been made into wire so delicate that two and a-half miles of it weighed but one ounce. The silver gilt wire used in making gold braid, spangles, and filigree, runs from 1,500 to 2,500 yards to the ounce, and it is not uncommon to draw it much finer. This exquisite fineness is obtainable only through the use of "gem draw-plates," which are drilled rubies, sapphires, or diamonds, and one who marvels at the exquisite delicacy attained by wire drawers must marvel the more at the almost unbelievable skill exercised in drilling precious stones, to obtain draw-plates which permit the wire workers to draw down metals into filaments whose diameters cannot be measured by the most delicate of micrometers but must be calculated by the mathematician.



ENGINEERING PROGRESS

Steam-Driven Street-Car

THE city of Paris has probably as many different varieties of street-car service as any community in the world, embracing steam, electric, animal, and compressed-air power. Strange to say, one of the latest methods introduced is where steam is employed directly for operation, and thus far it has proved very successful. It is known as the Purrey steam system, and, as the photograph shows, the car is really a dummy which may be utilized by itself or with a trailer.

The mechanism is so compact that it takes up but a small amount of space, the boiler and furnace being mounted upon the platform, while the steam engine is placed in the middle of the truck and below the floor of the car. It is of the two-cylinder type and propels the car by a chain drive. In addition to furnishing motive power, the engine runs a small air-compressor employed for braking. Sufficient horse-power is generated to give a maximum speed of twelve miles an hour, although the average rate maintained is about eight miles per hour. The total weight of a car, including the engine, is but ten tons without the passengers, and each car will carry about 35 people. It is an interesting fact, that, although coke is used for fuel, the expense of operation is very small, even compared with that of the ordinary trolley car, being less than two cents for each car mile.

STEAM STREET-CAR USED IN PARIS.

Loading Logs by Machinery

IN lumbering operations in the Northwest, what might be called a locomotive loader has been utilized with great success. It is really a traveling boom crane,

and when used as a locomotive, can be driven along the track at a speed of from 3 to 5 miles an hour depending upon the load which it is hauling. By means of the double-boom derrick, logs can be

Double-Boom Derrick at Work.

lifted from piles alongside the track and loaded on cars, while, by utilizing a cable system, they can be hauled from portions of the forest a thousand or 1,500 feet distant from the railway, and dragged to the side of the car.

trucks themselves, can be lifted entirely from the rails, leaving a clear space high enough to allow an ordinary logging car to be run beneath the loader. The steel legs supporting it are attached to shoes placed outside of the rails, so that the passage of the car is not obstructed. In this way empty cars can be shifted underneath the loader, being pushed by hand or hauled by means of the rope attached to the derrick. As fast as a car is loaded, it can be pushed forward. The loader will handle logs 60 feet in length, and with a crew of a half-dozen men will readily perform as much labor as one hundred hands.

Raising a Fallen Locomotive

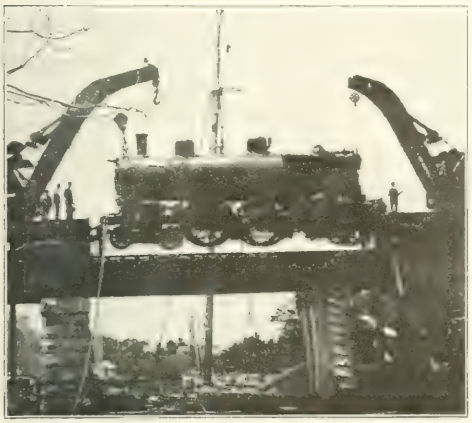
THE utility of the modern steam crane was demonstrated in a very interesting manner in the town of Laurel, Delaware. Here the track of the Pennsylvania Railroad crosses a navigable river at a height of about

LOGGING CARS RUNNING BENEATH THE LOADER.

The most interesting feature of the loader, however, is the fact that it can make up its own trains. At each corner of the device is a steel leg which is adjustable. By means of these legs the engine, boiler, and boom, as well as the

forty feet above the surface of the water. A draw is used, to allow vessels to pass through the bridge. The engineer of a passenger train missed the signal of the bridge tender, and ran into the open draw, with the result that the

engine itself was deposited upon the deck of a schooner which was passing through, completely wrecking the vessel, and tearing the tender from the locomotive. To extricate it from its position, presented a difficult engineering problem, which



Raising a Fallen Locomotive.

was solved with the aid of the wrecking crane. Two cranes, having a lifting capacity of forty tons each, were hauled to the scene of the accident, one being placed on each side of the wrecked draw. Steel girders were thrown across the open space, and upon these a temporary track was built. Then chains from the jibs of the cranes were carried to the locomotive, one being placed around each end of the boiler, and securely toggled. With no other assistance, the great mass of steel and iron, weighing nearly fifty-five tons, was hoisted a distance of nearly fifty feet, then swung laterally a distance of about ten feet. Although each crane had to be operated independently of the other, so uniform were their movements that the engine was lowered to the rails without difficulty and placed upon them without the use of a single jack-screw or block. Had the cranes not been available, it would have been necessary to separate the locomotive boiler from the running gear in order to perform the work. Train service was resumed over the line within twenty-four hours after the accident occurred. With the use of hand tackle, however, the engineers state that service would not have been resumed for fully a week.

Novel Traveling Wood-Saw

THERE has recently come into use in the rural districts a novel machine that almost entirely dispenses with manual labor in converting the long sticks into usable lengths. The operator can sit on the wagon-like frame of the machine, cut a cord of wood in 30 minutes, then ride on his machine to another wood pile in an adjoining lot, cut it in the same length of time, and likewise repeat the operation throughout the day.

The power by which the machine is operated is a 2-horse-power vertical gasoline engine connected by a belt to a 24-inch circular saw. The apparatus is mounted on an ordinary platform wagon, and so arranged that it can be transported from point to point. Parties owning the outfits have been making somewhat phenomenal records throughout their territory. A cord of wood has been sawed in a remarkably short time, but the average running throughout a day's sawing is about 30 minutes for a cord cut twice. This means very rapid work as any one who has sawed wood by the old-fashioned method with cross-cut saw can readily realize.

Running Over Obstructions.

Rough-Road Automobile

THIS picture represents a remarkable automobile. It is the design of a Chicago engineer, George T. Glover, and it is invented especially for running over uneven surfaces. As the photograph

shows, it not only has the usual number of wheels, but in addition contains what might be called a driving wheel, which can be lifted off the ground if desired when high speed is to be developed. When needed to give tractive power, it is lowered to the ground and is of great value in forcing the vehicle ahead. This driving wheel is connected with the front axle and exerts a pushing and lifting force which is of great power. By employing this idea a vehicle can be forced over stones and other obstacles several inches high.

Mr. Glover has employed the same idea in a traction motor for hauling logs and other heavy weights in the woods especially in winter. The mechanism is mounted upon sledges, and includes a large cylinder which rolls upon the ground, thus forcing the motor ahead. This apparatus is so powerful that it has hauled a load of 300 tons over ordinary snow-covered roads.

WONDERFUL SAND WAVES OF COLUMBIA VALLEY.

Sand Waves

IF it were not for the man in the center of the picture, one would readily imagine these formations to be immense breakers of the sea. As a matter of fact they are waves of a great "sea of sand," as it is called, which can be seen in the Columbia valley in the State of Oregon. The wind sweeps along the valley with such force that the loose sand is divided into this peculiar formation. The waves increase so in size that they sometimes cover trees 40 and 50 feet in height, to the topmost branches, and have completely buried houses to the height of 20 and 30 feet. The sand is brought into the valley by the Columbia river during the flood season. When the latter recedes, a large portion of the river bed is exposed, and the sand becoming dry is easily moved by the wind. In the distance the river can be plainly seen, giving the picture the appearance of a marine view, although all of the formation in the foreground is composed entirely of sand.

Gigantic Music-Stand

SAN FRANCISCO, California, can truthfully boast of having probably the largest, most expensive, and most beautiful music-stand in the world. It is constructed entirely of fine granite, and is located in the famous Golden Gate Park. The center, or music-stand proper, consists of a square, tower-like structure rising nearly eighty feet high above the

foundation. Though massively constructed, it has a light, airy, and very graceful architectural effect. On the front side is the vast "Sounding Shell," or concave, over fifty feet in height, ununder which the musicians sit on a platform capable of accommodating over 100 musicians.

Extending north and south, are two long, wing-like colonnades, each about 60 feet in length, and 45 feet high, and each supported by 32 beautiful Corinthian columns 36 inches in diameter at the base and tapering gracefully upwards. Leading up to the base of these polished and shapely columns, are broad, massive stone steps.

There is not a stick of timber, or bolt or bar of metal, in the entire structure, everything being built of California granite and sandstone. The cost of the structure was $75,000.

STAIRWAY VIADUCT AND BRIDGE IN PITTSBURG.

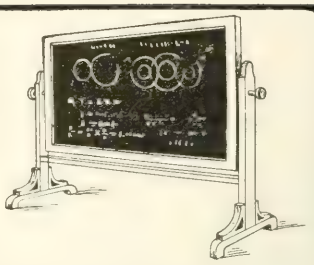
Stairway Bridge

ONE of the oddest viaducts in the United States is located in the suburbs of Pittsburg. As is well known, the topography of the city is extremely hilly, some of the streets in the upper portion being over a hundred feet above the beds of the rivers. At the point where the structure which is illustrated is located, a portion of the Pennsylvania railroad yards as well as the main line occupies a considerable space parallel to the bank of the river. Below the railroad tracks, however, is a thoroughfare which extends along the docks. To connect this thoroughfare with the upper part of town, the bridge was planned. As will be noted from the photograph, it is principally sustained on a single pier of stone masonry, built into the hillside on a level with the railway tracks. From the pier extend horizontal and oblique braces as well as three columns of lattice work, this part of the structure forming an irregular triangle. Yet its only support beneath is the pier of masonry referred to. A few feet beyond the left end of the triangle, the upper structure of the bridge is upheld by two steel girders, while the section parallel to the hillside is supported by a form of cantilever in addition to ordinary posts.

The grade of the viaduct is so steep, that it is supplied with steps for pedestrians, forming a gigantic stairway. From an engineering point of view, the bridge involves no new constructional principles, but is a novel application of well-known methods.

CHALK TALKS

by CARL S. DOW.



Number Twenty-One—Return Steam Trap

STEAM traps are necessary accessories in almost every steam plant. They are used for collecting condensed steam from heating coils, cooking and drying apparatus, and steam jackets. They are also used for feeding boilers, both high-pressure for power, and low-pressure for steam heating.

What Is a Steam Trap?

A steam trap is an automatic device consisting of a vessel in which a float controls a valve. In some cases the trap itself takes the place of the float and rises and falls as it empties and fills with water.

Classes of Traps

Steam traps may be divided into two general classes: separating or tank traps, and return traps. The first-named class is for the purpose of separating water from steam; that is, as the steam in the cylinder jacket or the heating or cooking coils becomes cooled, a part of it condenses, and this condensed steam (water) flows down to the trap. The water enters the trap, but the steam is kept out.

The return trap is for feeding boilers, that is, for returning direct to the boiler hot water from heating or drying coils.

Principle of the Return Trap

A steam pump will force water into a boiler because the total pressure on the steam piston is greater than that on the water piston. Similarly, in the return trap the pressure on the water about to enter the boiler is made greater than the boiler pressure. This is accomplished by placing the trap three or four feet above the water line of the boiler.

When the steam pressure is on the water in the trap, the steam pressure in the trap is the same as that in the boiler, but the pressure in the feed pipe is increased a pound or two on account of the elevation of the trap.

Construction and Action

There are numerous steam traps on the market, many of which work satisfactorily. On account of its many excellent features, the one shown on the blackboard has been selected to illustrate the principle.

This trap consists of a pear-shaped, cast-iron bowl in which is a curved pipe having one end fixed in the small end of the bowl and the other end open at the highest part of the bowl. The bowl itself is movable; that is, the small end is hung on trunnions which allow slight rotating movement. The trunnions are hollow so that steam or water may flow through; one is connected with the pipe from the receiving tanks, and the other with a small steam pipe from the boiler. A partition in the small end of the bowl directs the water into the bowl and prevents its entering the pipe. This partition also compels the steam to enter the pipe.

A ring, which is formed on the end of the bowl, envelops a valve spindle; and as the bowl rises or falls, this ring falls or rises, and in doing so strikes a nut on the valve spindle, thus opening or closing the steam valve.

Two check valves are used—one to keep the water in the boiler from flowing back into the trap when the pressure is slight, and the other to prevent the water in the trap from returning to the receiver, or coils, when steam pressure is on the water in the trap.

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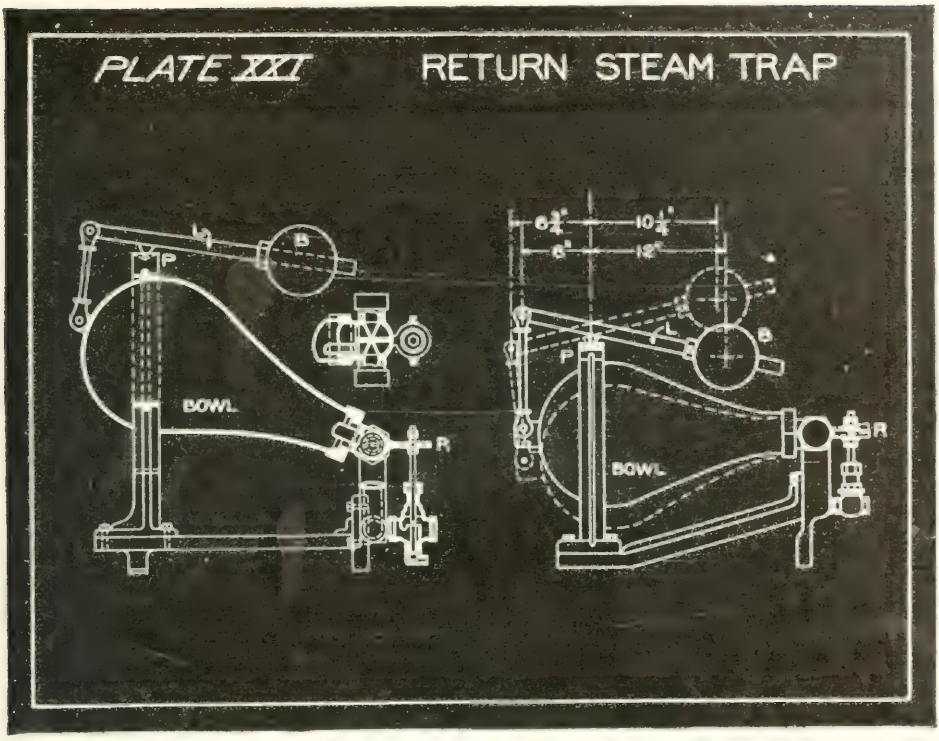


Operation

Let us suppose the water from the receiver, or coils, to be flowing through the trunnions into the bowl. When the bowl is full, or nearly so, the weight of water overbalances the ball weight B on the lever L, and the bowl falls. The ring R then rises and strikes the upper nut on the valve spindle; as the spindle and valve rise, steam enters the other trunnion, and, directed by the partition, flows into the curved pipe and thence to the bowl.

The pressure on the surface of the water in the bowl of the trap is now the same as that in the boiler; but as the trap is three or four feet above the water level in the boiler, the water in the bowl flows by gravity into the boiler.

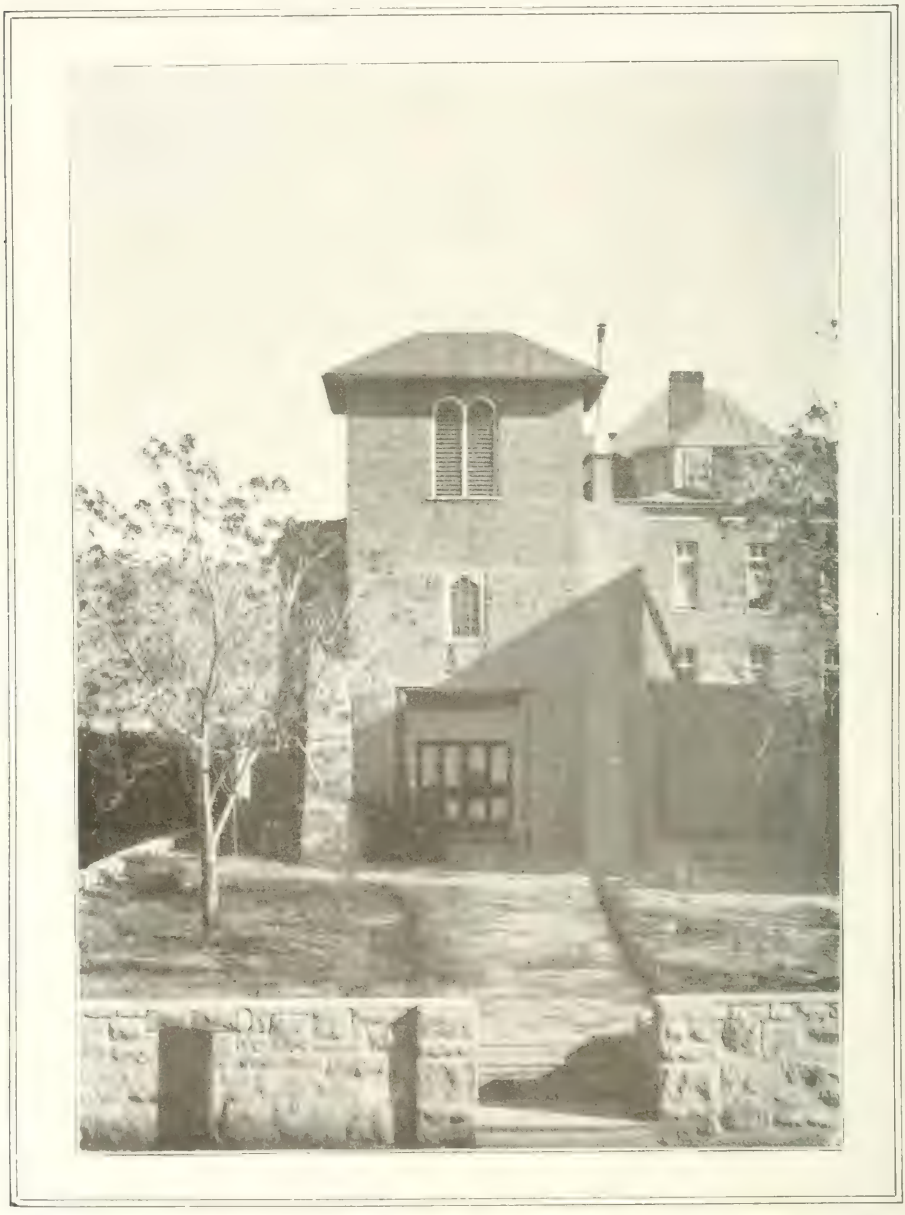
When the bowl is empty, it is of course much lighter, and therefore the ball weight B descends, raising the bowl. The rising of the bowl causes the ring to engage the lower nut on the valve spindle and close the valve. The trap then fills as before.

The Lever

Why is it that the trap empties itself completely? Why doesn't the bowl rise as soon as a little water leaves it? The answer to these questions is simply this: instead of being a cylindrical pin, the fulcrum of the lever is a point which projects from the side of the lever, as shown at P.

This point causes the effective lengths of the lever arms to change. This change of length alters the moment, as it is called. Since the moment is equal to the length of the arm × the weight, a decrease in the length decreases the moment, because the weight remains the same. Now if one arm is decreased, the other arm is increased, and to balance the given moment, the weight (the bowl and contained water) must be decreased, but it is not decreased until some water has left the bowl. Therefore, the tilting of the bowl will not take place until the moments have become equal, and this occurs only when all the water has flowed out of the bowl.

WHERE HISTORY



Church of San Miguel at Santa Fé, New Mexico. This church, dating back to about 1550, is said to be the oldest chuch in the United States and is therefore called the "Cradle of Christianity in America." The original structure was destroyed by Indians, but the church was rebuilt in 1710. Santa Fé, the capital of New Mexico, is the oldest settlement in the United States. It is the center of a great agricultural and stock-raising region abounding in mineral resources. Its streets are narrow and crooked, and most of its buildings are of adobe, or sun-dried brick.

WAS MADE

The Newbury Elm. In 1713 this tree was planted by Richard Jaques, one of the first settlers of Newbury, Mass. It is the largest elm in the country, 85 feet in height, 95 feet from bough end to bough end. It is concerning this tree that Hannah Gould wrote:

"Did it ever come in your way to pass
These [illegible] with its [illegible] of grass,
And, the while, the time heard by, to see
The veteran Elm of Newbury?"

Birthplace of General Israel Putnam at Danvers, Mass. General Putnam was born January 7, 1718. Served in the French and Indian wars, and was one of the commanding officers at the battle of Bunker Hill.

Electric Train-Lighting

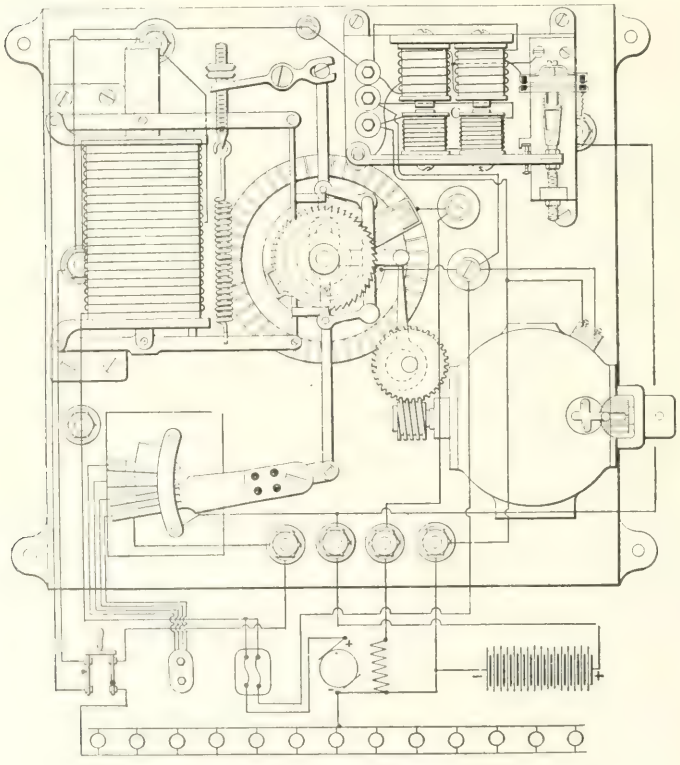
General Principles of Some European and American Equipments Explained and Described

By FRANK C. PERKINS
Consulting Electrical Engineer

DURING the past decade there has been a steady improvement in the methods of lighting steam railway trains by electricity, both in the United States and in Europe. Prominent electrical engineers in European countries have developed successful systems, most of which utilize the power of the moving train for generating the lighting current. In the United States some of the most luxurious trains in operation are illuminated by electric lamps operated by very successful systems developed by American engineers.

It may be of interest to consider some of the more prominent systems for lighting railway trains. The accompanying illustrations show the arrangement of some of the apparatus employed.

The electric train-lighting systems finding the most favor in America at the present time, are those consisting essentially of a generator installed upon the truck of the car and driven from the axle, a storage battery hung in a suitable box from the car body, and a regulator located within the car.



WIRING DIAGRAM OF AMERICAN "AXLE LIGHT" SYSTEM.

Axle Light System

The axle light system of the Consolidated Railway Electric Lighting and Equipment Company utilizes a pressure of about 32 volts with 16 cells of storage battery. This voltage is claimed to have been found the best for the purpose, as it allows the use of a small number of batteries and a lamp of high efficiency, with a filament which is not easily broken.

The output of the generator is controlled by varying the resistance in its field circuit to correspond to the varying train speed, the controlling mechanism being thrown into action whenever the output of the generator varies from the normal. The generator shown in the accompanying illustration is a shunt-

wound bipolar machine which is iron-clad, and provided with self-aligning and self-oiled bearings. It is provided with a flanged crown pulley, and on the axle is clamped a flat-face driving pulley, the two being belted together with a rubber belt. The armature shaft carries a worm operating a gear and cam, which throws a switch when the direction of the rotation of the armature is reversed, as in the case when the car changes its direction. The polarity of the generator is thus maintained correct, independently of the direction in which the train is moving.

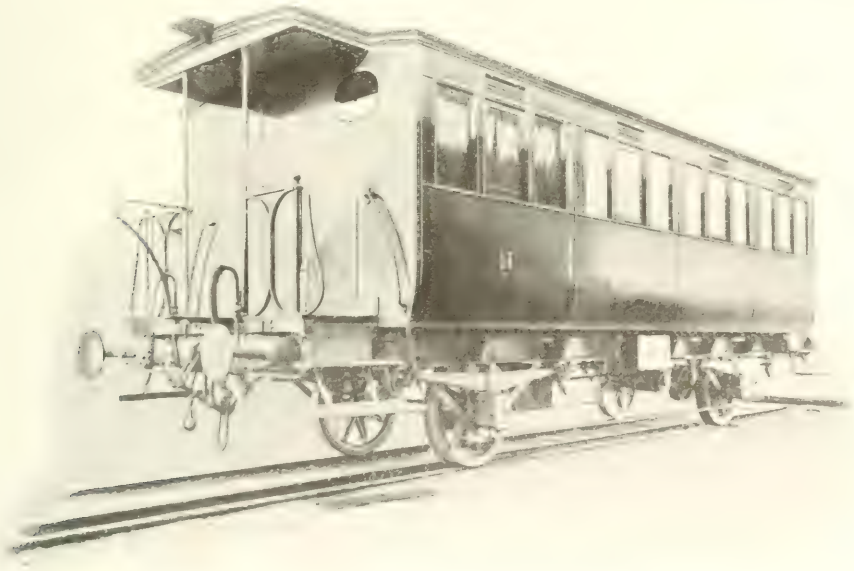
The regulator contains a solenoid; the generator field rheostat and a small electric motor to operate it; an automatic switch or "cut-out" for automatically switching the generator in multiple with the lamps and battery and for cutting it out at the critical speed; and a variable lamp resistance.

Miesler Switch Circuit

In 1898, Julius Miesler, of Vienna, designed an arrangement to control the incandescent lamps on a train by means of any one of a number of switches located in the cars. Each of the several switches is normally maintained open; but when it is desired to illuminate the cars, any one of the switches may be closed, which will result in immediately securing the simultaneous illumination of all the cars of the train. Thus the trainman is enabled to control the lighting of an entire train from any one of the several switches provided upon the car. The utility of this arrangement will be appreciated when it is considered that demands are often made—as, for instance, when numerous tunnels are encountered—for the frequent illumination and extinguishing of the lamps of a train.

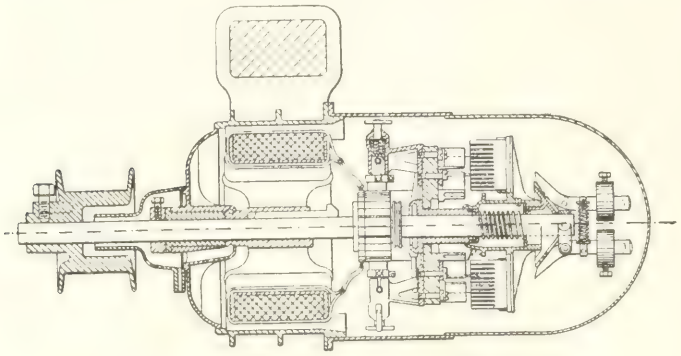
Preston and Gill System

Two English engineers, Edwin James Preston and Arthur Bernard Gill, in 1899 and 1900, invented systems of electric train lighting and special automatic controlling apparatus, embodying the use of two storage batteries and a dynamo driven from one of the car axles, the dynamo being provided with an automatic current-reversing mechanism, whereby the current is reversed when the rotation of the dynamo is reversed. There is also an automatic switch whereby the connections between the storage batteries and the charging circuits are automatically alternated upon the reversal of rotation of the dynamo. A resistance is usually arranged between the



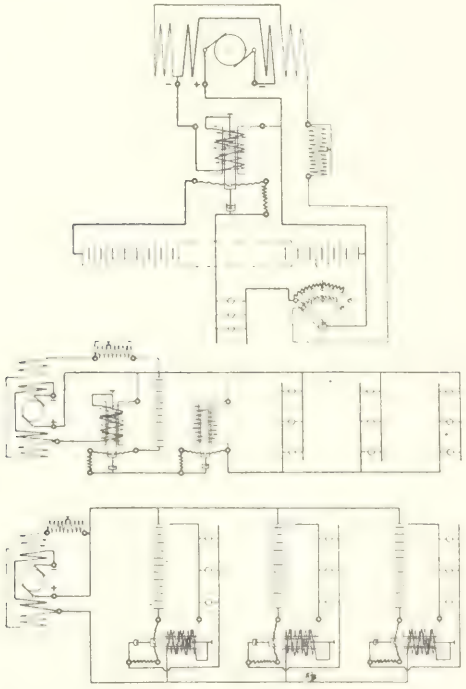
TYPE OF FRENCH CAR EQUIPPED WITH VICARINO SYSTEM.

dynamo and the lamps, so that the current is directed to the battery which is being charged while the other battery is in direct connection with the lamps, fans, or electric heaters.



Car-Lighting Dynamo and Switch—Preston and Gill System.

Preston and Gill provide means for cutting out the resistance when the lamps are cut out and to connect both batteries with the dynamo without the intervention of the resistance, so that both batteries will be charged simultaneously from the dynamo. When the car provided with this apparatus is running during the daytime, and no lamps are required, the entire output of the dynamo is sent by this means to both batteries and no part of the current is wasted by overcoming the resistance. They also provide means for preventing the battery which contains the preponderating charge from discharging suddenly into the less strongly charged battery when the dynamo is put out of operation by the stopping of the car, and both batteries are connected in parallel with the lamps. This is effected by arranging the connections so that part of the resistance is included between the two batteries, and the current cannot pass from the preponderating battery into the other battery except by passing through this resistance.



Connections of Vicarino Electric Car-Lighting System.

Vicarino's Train-Lighting System

In 1900 a Swiss engineer, Charles Vicarino, designed a unique system of electrically lighting railway carriages, which is being extensively introduced by the *Compagnie Générale Électrique* of Nancy, France. This invention provides an automatic pole changer combined with a dynamo, a battery of accumulators fixed to the under frame of the car, and an automatic switch disposed between the dynamo and the accumulator. The accompanying illustration shows the arrangement of this apparatus. Whether the dynamo revolves in one direction or the other, the current transmitted to the external circuit flows always in a uniform direction.

The lamps used on the cars of this French system as well as other European trains range from 5 to 10 candle-power, and are not only lower in candle-power but also fewer in number than those used on the American railway trains. The pressure used on the Vicarino system is low, being 32 volts, as only 16 cells of storage battery are employed, the current ranging from 6 to 16 amperes. The sets of accumulators employed supply the necessary current for lighting the train for from 6 to 9 hours, and have a capacity

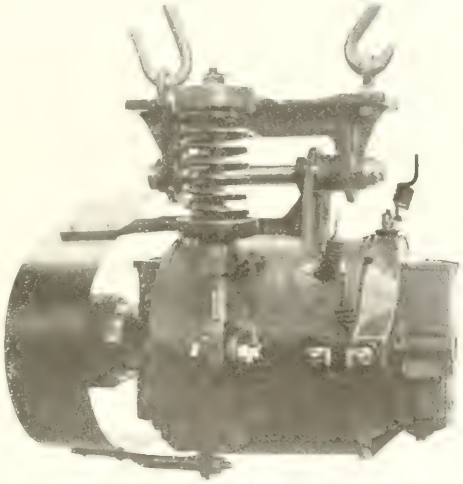
of from 60 to 120 ampere-hours each. The dynamos used under the car reach a speed of 250 revolutions per minute when the train is moving at 50 kilometers per hour, which is the usual rate for the accommodation train, while the express trains operate at from 60 to 90 kilometers per hour. By means of the Vicarino automatic regulating apparatus the voltage at the lamps is maintained practically constant, regardless of the speed of the train.

Zehden System

In 1901, Alfred Zehden of Charlottenburg, Germany, designed an electrical equipment of railway vehicles for the purpose of lighting, heating, and ventilation. This system also included a storage battery and a dynamo mounted on a shaft parallel with one of the car axles and driven by the same by a suitable transmission device to supply the current when the car is in motion. When the car is standing, or its speed is below normal, the lamps are fed from the storage battery; but when the car attains its normal speed the dynamo is automatically switched in by a mechanism, the action of which depends, to some extent, upon the degree to which the storage battery is charged and the resistance that is switched into the lamp circuit. Zehden also provided certain devices for protecting the storage battery so that after the same is fully charged it is automatically switched out of the circuit; and also means for protecting the collecting brushes, so that the same are not used during the day when the lighting of the cars is not required.

Dick Train-Lighting System

Mr. Emil Dick, of Baden, also invented a system of electrically lighting railway cars which includes the usual dynamo, battery, and lamps, together with an automatic commutator and a resistance-regulator, which are shown in the accompanying drawings in connection with the batteries and lamps. By this system the dynamo supplies current to the lamps of the lighting circuit at all times when the train is operating at a speed of not less than 25 kilometers per



Car Lighting Dynamo of the Dick System.

hour. The maximum capacity is 25 amperes at a pressure of 45 volts with a speed varying from 700 to 2,400 revolutions per minute.

Pintsch Centrifugal Coupling

Richard Pintsch, of Berlin, in 1902, invented a centrifugal coupling and other interesting devices for generating electricity on running cars. The Pintsch coupling is designed to come into operation only when the driving shaft is rotating slowly, and to become disengaged as soon as the shaft exceeds a certain predetermined speed of rotation. The transmission of power is effected with the aid of an electro-magnetic coupling, the operation being controlled by its

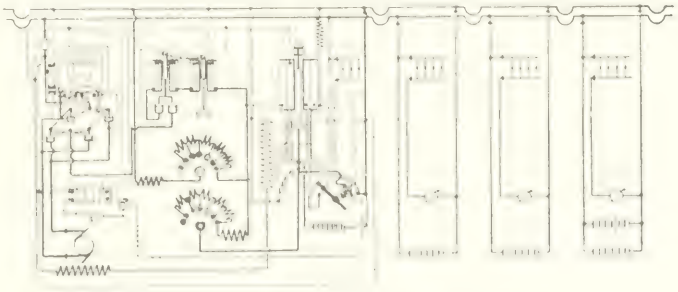
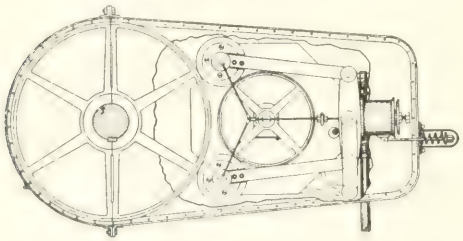


Diagram of Dick System of Electric Car-Lighting.

switch. Both of these devices of Pintsch are of particular interest.

In 1901 a German engineer, Otto Böhm, of Berlin, patented in the United States a mechanism for transmitting power to dynamo machines, regulating the speed of the dynamo independently



Bohm Car-Lighting Dynamo and Transmission System.

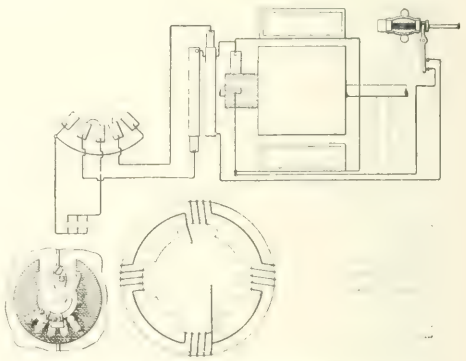
of the speed of the driving pulley in such a way that the pressure or the current is kept at a constant predetermined figure. His invention consists in interposing frictional transmitting devices between the driving and driven parts, supplying constant means, such as the force of gravity or a spring, to produce a certain amount of frictional pressure, and providing an electro-magnet to counteract the frictional pressure, the excitation of which is controlled by the terminal pressure of the driven machine itself. As soon as the speed of the driven part rises above the predetermined rate, the terminal pressure will also exceed the predetermined figure, and the force of the electro-magnet will consequently surpass the force producing the frictional pressure, thus reducing or altogether suspending the latter, and thereby also suspending temporarily the driving force.

Hutchins System

In 1902 Mr. Stainer Hutchins of Manchester, England, designed a dynamo for electric car-lighting, in which the voltage or tension is automatically kept constant at varying speeds of the armature.

This invention is based on the principle that if the field magnets of the dynamo are mounted so that they can rotate and follow the armature, which they tend to do when current is taken out, and a constant difference of speed is maintained between the armature and the field magnets, then the voltage will also remain constant.

In the United States Mr. George Gibbs, of Milwaukee, Wisconsin, was one of the first engineers to design and utilize electricity for lighting railway trains. In 1891 he patented an electric lighting system in which the current is supplied to the lighting circuit by a dynamo driven by a steam engine. He found that in practice in the use of the ordinary system of electric car-lighting, the coaches were frequently left in darkness by an interruption of the circuit due to the breaking of the train accidentally, or during the addition or removal of cars, or owing to failure of steam supply. He provided an auxiliary lighting system to come into action automatically during any temporary interruption of the main switches. In applying this system, the dynamo is located at the forward end of the train operated by an engine receiving steam from the locomotive, and a main circuit extended to the rear through all the cars of the train. Each car was provided with a storage battery, a secondary l. hting circuit, and a switch. By this arrangement each car contains a system for its temporary illumination, entirely



Hutchins Dynamo and Car-Lighting System.

independent of the main system and of the system on the adjacent cars, so that the cars may be separated from each other and from the source of steam supply for short periods of time without danger of being in darkness.

The earliest systems of electric train-lighting in the United States utilized a steam engine and dynamo, practically an independent isolated plant, in the baggage car. Mr. Frank M. Garland, of New Haven, Conn., designed a system

of lighting railway cars, using the axle for driving an air pump, and storing the air in a cylinder, utilizing the energy for driving a dynamo by an air motor. As long as the car was in motion, the pumps could be operated to compress sufficient air into the cylinders and generate enough force to keep the engine running for a short time after the car had stopped. The engine operated the armature of the generator which supplied current for lighting the lamps and charging the storage battery. When the air pressure became reduced and the engine slowed down so that the dynamo failed to generate sufficient electricity to light the lamps, the excess of the electromotive force of the storage battery closed a circuit, and the lamps were lighted by the discharge of the batteries. On the increase of the electromotive force of the dynamo the batteries were automatically cut out, and the lamps again lighted by the current from the dynamo.

The Old Places

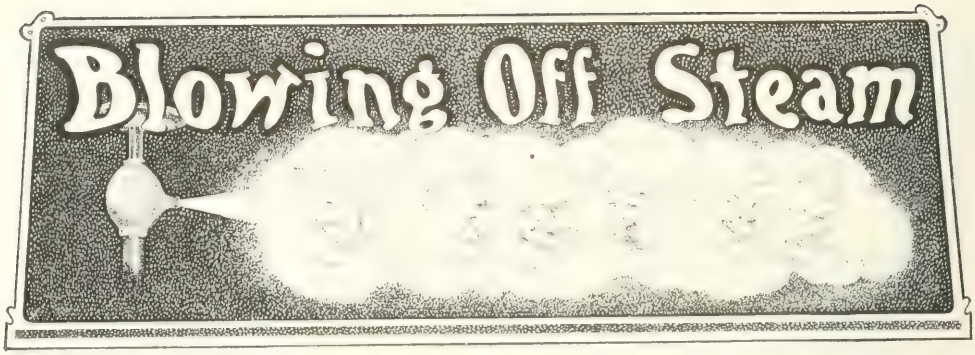
SAY, how would you like to go with me
Away from the greed and spoiling,
To a place I know where the fields stretch green
And there's naught of strife and toiling?
And how would you like to forget the noise
And these haunted city faces,
And bury them deep in the dreams we'd have
In the good old boytime places?

Say, how would you like to go with me
To the willow's friendly cover,
Down to the river where, long ago,
The pickerel used to hover?
And how would you like to wander again,
As we did with sunburned faces,
And bare, brown feet and ragged clothes,
In the good old boytime places?

Say, how would you like to go with me
And forget your tribulations,
In the romp and rove and heedless life
We knew in our school vacations?
And how would it be to find the pond,
The one where the old millrace is,
And dive in its waters cool and deep—
One of those boytime places.

Say, how would you like to go with me
And forget this make-believing
Forget these fleeting and tinseled joys
That cover up the grieving?
It seems to me it would be so good
To go where naught defaces
The world as it was when made by God—
In the good old boytime places!

—WILL F. GRIFFIN, *in Milwaukee Sentinel*



Right on Hand

MRS. VAN DUER—Now, Bridget, I'm going to give a supper and a dance this evening, and I want you to show my guests what you can do.

THE NEW COOK—Well, mum, I won't disappoint yez. I tuk th' prize at th' firemen's social hop as th' bist lady dancer on th' flure. —*Cleveland Leader.*

Sweets Not to the Sweet

THEY were newly married and on a honeymoon trip. They put up at a skyscraper hotel. The bridegroom felt indisposed, and the bride said she would slip out and do a little shopping. In due time she returned and tripped blithely up to her room, a little awed by the number of doors that looked all alike. But she was sure of her own and tapped gently on the panel.

"I'm back, honey; let me in," she whispered.

No answer.

"Honey, honey, let me in!" she called again, rapping louder. Still no answer.

"Honey, honey, it's Mabel. Let me in!"

There was silence for several seconds; then a man's voice, cold and full of dignity, came from the other side of the door:

"Madam, this is not a bee hive; it's a bathroom!"—*New York Sun.*

Corpus Delicti

LAWYER—Now, see here; before I take your case, I want to know if you're guilty?

PRISONER—Am I guilty? D'yer s'pose I'd be fool enough ter hire the most expensive lawyer in town if I wuz innercent?

Something Wrong

"THERE's just one thing I wanted to say to you," began Mrs. Acid to her better half.

"Only one, M'ria?" queried he, solicitously. "Aren't you feeling well?"—*Tit-Bits.*

A Difficult Position

Two Irishmen were crossing a bog, when one of them fell into a mud hole. His companion, running to a nearby farm-house, asked the loan of a spade.

"What do you want it for?" asked the farmer.

"Sure, Mike is stuck in the bog, and I want to dig him out," was the answer.

"How far in is he sunk?" questioned the farmer.

"Up to his ankles."

"Begorra, then he can easy walk out."

"Begorra, he can't," exclaimed Pat, "he's in wrong end up." *Harper's Weekly.*

He Saw It

AN American touring in the country with an English friend stopped to point out to him a sign-post on which some wag had printed this sign:

"This way to Squedunk. Those who cannot read apply at the blacksmith's opposite."

The American roared with laughter, but the Englishman looked puzzled. After they had returned home that night, the Englishman came into his host's room roaring with laughter.

"Ah," he said, "I see the joke now—suppose the blacksmith were out?"

A Quare Thing

"THEY call it electric light," Pat confided to his lordship, "but it do beat me how they make the hairpin burn in the bottle."

Definition of an Orphan

"WHAT is an orphan?" asked the teacher of the class in definitions. Nobody seemed to know. "Well, I'm an orphan," said the teacher, seeking an illustration that would not reveal too much. At this a hand popped up, and the owner of it exclaimed: "An orphan is a woman that wants to get married and can't."

Why He Saw Ingersoll

SOME years ago Phillips Brooks was recovering from an illness, and was denying himself to all visitors, when Robert Ingersoll called. The bishop received him at once. "I appreciate this very much," said Mr. Ingersoll, "but why do you see me when you deny yourself to your friends?"

"It is this way," said the bishop; "I feel confident of seeing my friends in the next world, but this may be my last chance of seeing you."—*Argonaut.*

He Didn't Mind

"I SUPPOSE, Jerry," said the eminent statesman, looking through his pocketbook for a new dollar bill, "like a lot of other people nowadays, you would rather have clean money?"

"Oh, that's all right, Senator," said the cabman. "I don't care how you made your money."—*Ladies' Home Journal.*

Up-to-Date

A ST. LOUIS man, being requested by his wife to bring home the latest pattern sheet, astonished the clerk by asking for the latest style in sheets.

A la Kneipp

THE art of reproving impertinence is practiced in its perfection by women more frequently than by men. The Cincinnati *Enquirer* tells this story of the experience of a young man who was taking a walking trip in Scotland:

One day, on a quiet road, he met a young woman, tall and comely, who walked barefooted. The traveler was surprised; and in an honest quest for information, he stopped her to ask:

"Do all the people go barefooted?"

"Some of them do," she answered, with dignity. "The rest mind their own business."

How the Ship was Saved

"YES," said the yarn-spinning old mariner, in the corner of the railway carriage, "for three days and nights we worked at the pumps, and still the water gained on us. At last we gave up the hopeless struggle. There we was—sinkin', sinkin', expecting to perish every 'arf a minute. It was a horful time, believe me. Sudden-like we feels the wessel a-rising up through the water. She riz till her keel was a'most out o' water, and we rides into port light on top o' the waves. We was saved! 'Ow it happened was, we had a cargo of yeast on board, and when the water reached it, it rose and rose, till it fairly lifted up the ship!"

The Torn Trousers

ARRIVING quite late at a dance one evening, Mr. Jones discovered that in slipping on the icy pavement outside, he had torn one knee of his trousers.

"Come into the ladies' dressing room, John," said his wife. "There's no one there and I'll pin it up for you."

Examination showed that the rent was too large to be pinned and Mrs. Jones began to look about for sewing material. A maid furnished needle and thread, and was stationed at the door to keep out intruders, while Mr. Jones removed his trousers, putting on his overcoat to serve as a robe, and his wife went busily to work.

Presently at the door sounded excited voices.

"We must come in, maid," a woman was saying. "Mrs. Brown is ill. Quick, let us in."

"Here," said the resourceful Mrs. Jones to her terrified husband, "get into this closet for a minute."

She opened the door and pushed her husband through it, just in time. But, instantly, from the opposite side of the door, came loud thumps and the agonized voice of Mr. Jones, demanding that his wife open it at once.

"But the women are here," Mrs. Jones objected.

"Oh, confound the women!" profanely answered Mr. Jones, with another and louder thump. "I'm out in the ball room."

Doing His Employer's Work

"YOUNG MAN," said the old merchant, sternly, "I caught you kissing the typewriter when I returned to the office this morning. What have you to say sir?"

"Why," replied his bright clerk, "you told me to attend to all your duties in your absence."—*Philadelphia Press.*

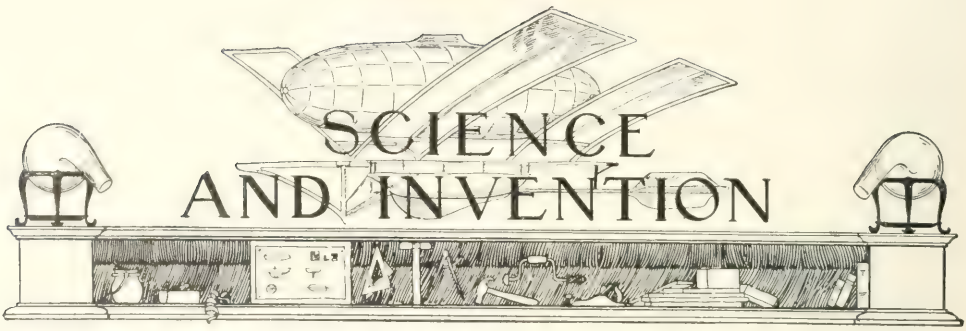
When He Let Them Out

"Do you let out your dress suits?" inquired Jones of the fashionable tailor. "Only when they are too small, Sir," replied the sartorial artist, cuttingly.

His Treasure

A SCOTCH laboring man who had married a rich widow exceptional for her plainness, was accosted by his employer. "Well, Thomas," he said, "I hear you are married. What sort of a wife have you got?"

"Weel, sir," was the response, "she's the Lord's handiwork, but I canna say she's his masterpiece."—*Harper's Weekly.*



To Resist Ocean's Fury

TO supply the city of San Francisco, Cal., with a liberal allowance of pure sea water, is a great undertaking. There are hundreds of salt bathing establishments in the city, and sea water is used for various other purposes besides.

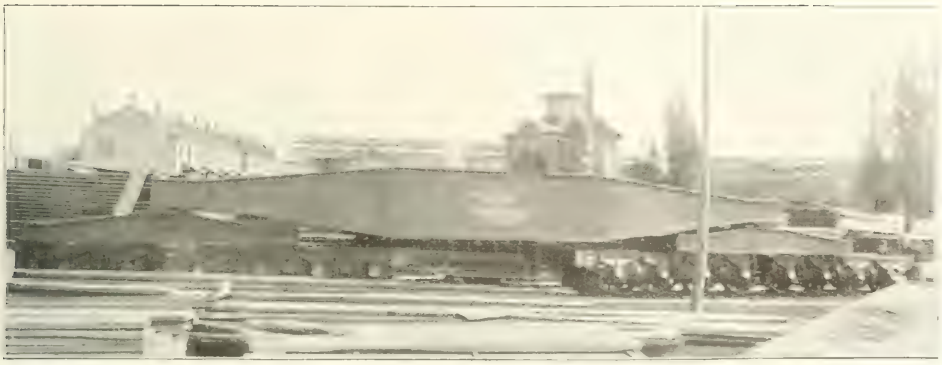
A large pipe line extends from the beach over the hills and up into an immense reservoir, from which the water is generally distributed. This pipe-line is more than five miles long. Very powerful pumps are in constant operation at the beach, to drive the water up into the reservoir.

In order to obtain the water entirely free from sand, an iron pier was built some years ago far out into the sea, on which structure the great water main is laid. Though this pier was strongly built, the perpetual poundings of the huge breakers in time wrought havoc. The massive steel supports were twisted, bent, and torn from their fastenings. Very recently some substantial repairs were made to the outer end, but this work was done with great difficulty.

A great number of round steel "piles" were used. These giant rods, or sticks, were 60 feet long and 8 inches in diameter, each weighing over 4 tons. They were driven nearly half their length into the hard, wave-beaten sand by a powerful pile-driver. Upon the top of each was placed a cast-iron cap, weighing two tons. These caps were hollow, the concave side being on top. Steel braces were fitted into these ponderous caps, the whole being massively connected and bolted. Then concrete was poured into the hollows of the caps, and this, hardening into stone, made the whole end structure "sea-proof." The massive ironwork can now bid defiance to the incessant fury of the breakers for years to come.

The work was prosecuted under many difficulties, the chief obstacles being the heavy tides and the never-ceasing lashing of the angry breakers. The nature of the structure is novel and original, and the work involved a large outlay of money.

PIER WHICH SUPPLIES SAN FRANCISCO WITH SEA WATER.



MAMMOTH PLATFORM CAR.

Massive Platform Car

IN the accompanying cut is shown a model of a platform car which will probably carry the heaviest weight of any railroad car in the United States. It is owned by the Pennsylvania Railroad Company, and is utilized in transporting heavy ordnance, blocks of iron and steel for bridges and buildings, marble for monuments, etc. It will support a weight of no less than 150 tons besides its own weight, owing to the ingenious manner in which it is built. As will be noted, it consists of a large center platform, which rests upon two others, each of which is in turn supported by double trucks, and each pair of trucks having no less than sixteen wheels. In addition, however, girders resting upon the ends of the inner trucks support enormous steel springs, which are installed directly beneath the center piece, so that, when the car is loaded, the springs tend to equalize the pressure of the weight on all parts.

Blowing Out a Tunnel

IN railroad reconstruction, it does not often occur that a tunnel is blown out, and a deep open cut substituted. But this was recently done on one of the roads leading out from San Francisco, Cal., to the seaside at the Cliff House.

It was recently determined to change the road from steam to electric power. For a part of the distance the route extends very near the ocean—winding along the edge of a high cliff. At one point a tunnel had been bored through the heart of a lofty projecting spur. The rock had been badly shattered, and the walls and top of the tunnel had to be very strongly timbered. For many years this tunnel had been a constant source of trouble and expense, owing to slides and cavings. Sometimes the massive timbers were crushed and ground like so many matches.

In changing the road to electricity, the company determined to blow out com-

pletely the old tunnel, and to substitute a wide, open, double-track cut. This has proved a heavy and expensive task. A large force of men have been engaged at the work for a long time. Many hundreds of pounds of explosives have been used in the blasting, and about 200,000 cubic yards of rock removed. The side of the cut nearest the ocean is very deep, the distance from the tracks to the crest of the embankment being more than 100 feet.

Prevents London Overflows

POWERFUL and palatial pumping stations have just been constructed by the London (Eng.) County Council to prevent the disastrous flooding of lands in the low-lying districts of the city. There are nine of the

ONE OF THE GREAT PUMPING STATIONS.

stations, which are able to pump 632,424 gallons of storm water per minute.

None of the various kinds of London sewers is capable of carrying off a very excessive rainfall. On this account, storm overflows have been provided, so that, when the sewers become surcharged, the storm water overflows into these channels and is carried by them into the river. The storm overflows are in many cases on the lines of the old sewers, which, before the construction of the intersecting sewers, led the sewage directly into the Thames. Should there be a heavy rainfall at the same time as high tide in the river, the outlets of these storm overflows would naturally be closed by the water in the river. This has caused the flooding which has often played havoc in the low-lying districts.

Auto-Boats for Sportsmen

HUNTING and fishing bid fair to attain a prominence never before enjoyed, as a result of the invention of an automobile boat especially adapted to these sports. Unlike any other auto-boats yet built, these little craft are exceedingly hardy and seaworthy; they can plow their way through nearly any sea, bump into obstructions, and be beached almost anywhere. They have been called the "Seabright sea-skiffs" in honor of the New Jersey town in which they are made; but "huntsman's launch" or "rough-weather auto-boat" would be names equally appropriate. The boat built by Mr. Fleming of New York, shown in the illustration, is of cedar and oak, copper-fastened

SPORTSMAN'S AUTO-BOAT.

throughout, and put together so as to stand hard pounding. It is 23 feet 6 inches long, and is fitted with a 5-horse-power Buffalo motor.

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What the Real Jiu-Jitsu Is

The art of Jiu-Jitsu as taught by Mr. Yabe is the method of physical training, and the system of offence and defence, used by the Imperial Japanese soldiers for thousands of years. Much of the efficiency of this method is due to a number of simple but easy tricks, by which an assailant can be overcome.

Until recently it has been a crime of high treason for any one to disclose these secrets outside of the Imperial Schools, but Mr. Yabe secured permission from the Mikado to teach these arts in the United States.

If you wish to learn the art of self-defence; if you wish to know the tricks and secrets which will enable you to overcome any one; if you wish to know the system which has made the Japanese the nardiest, strongest, bravest and toughest people in the world, notwithstanding their small size, if you wish to enjoy perfect health and to indulge in fascinating exercises that make you strong and vigorous, write to-day for Mr. Yabe's **free lesson**, and full particulars of the art Jiu-Jitsu.

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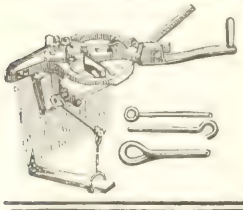

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We make *hand* power benders for forming eyes from stock 1⅜ inch thick and under. Any size eye 7 inches outside diameter and under.

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EXPERIMENTAL WORK. MODELS.
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Mammoth Vegetables

CALIFORNIA has long been famous for its gigantic vegetables. Sometimes exhibitions are given in which specimens from field and garden are compared with people. The accompanying illustration shows a pile of pumpkins, squashes, and gourds, against which a man of more than ordinary height is leaning. Such is the enormous size of the vegetables, however, that he appears to be dwarfed. The piece of garden "truck" which he is holding in his hand, actually measures six feet in length, which will give an idea of the proportions of some of the specimens comprising the pile. This collection was recently exhibited in the rooms of the Los Angeles Chamber of Commerce, where the photograph was taken.

MAMMOTH VEGETABLES.

It should be remarked in passing that the photograph is remarkable in more than one way.

Sour Milk and Longevity

SOUR MILK is the nearest approach to the much-sought "elixir of life," according to a statement made recently by Prof. Eli Metchnikoff of the Pasteur Institute. Anyone desiring to obtain a ripe old age is advised to emulate the Bulgarians, who consume large quantities of this cheap and easily obtained

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It would be a pity to have to spend hundreds, may be thousands of dollars, to correct an error that need not have occurred.

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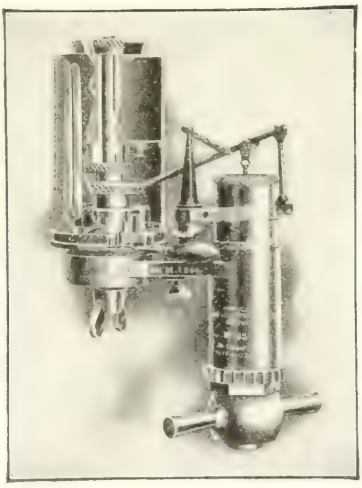

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A coating on the sensitive parts will protect the feet from being chafed or blistered by new or heavy shoes.

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are all liable to bruise, scratch or scrape their skin. "NEW SKIN" will heal these injuries, WILL NOT WASH OFF, and after it is applied the injury is forgotten, as "NEW SKIN" makes a temporary new skin until the broken skin is healed under it.

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DOUGLAS MFG. CO.
Dept. 100
96-102 Church Street, N. Y.

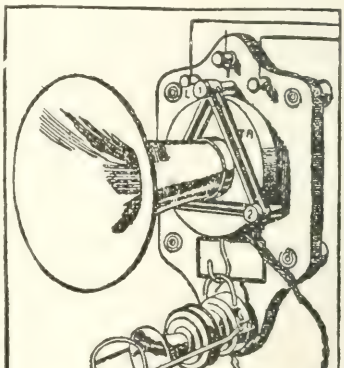
beverage, and who are noted for their longevity. The professor says:

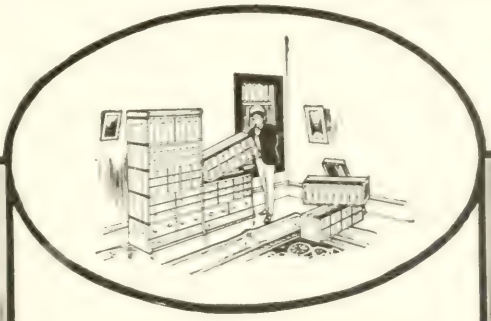
"Sour milk contains a large bacillus remarkable for the great quantity of lactic acid it is capable of producing. This microbe does not exist normally in the human body, but can be introduced with great benefit to the health, as it preys on the hundreds of thousands of microbes which infest the large intestine. It has been noted that there is a great similarity between old age and disease. The study of certain diseases has proved that there is no difference between the mechanism of senile atrophy and that of atrophy caused by the microbe on the person. In fact, on the approach of old age, a veritable battle is waged in the innermost parts of the body."

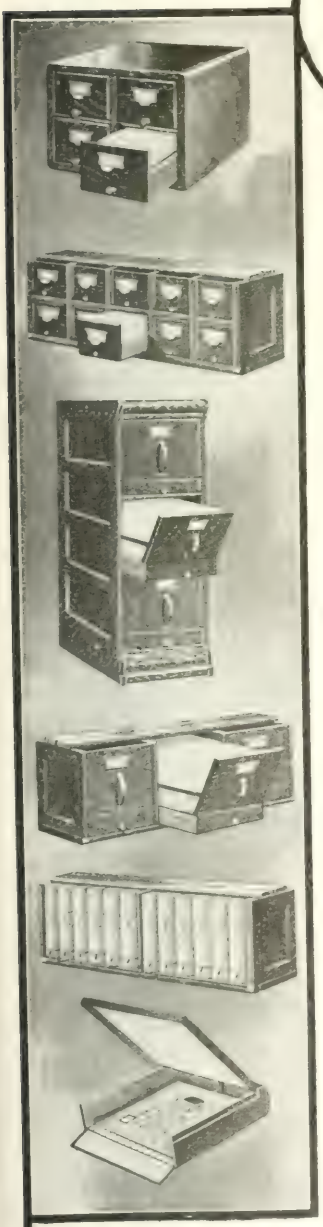
Research is being prosecuted to discover some means of strengthening the vital elements of the body on the one hand, and to weaken the aggressive tendency of the harmful microbes on the other. When this has been attained, Professor Metchnikoff hopes to be able to prolong life considerably beyond the present average.

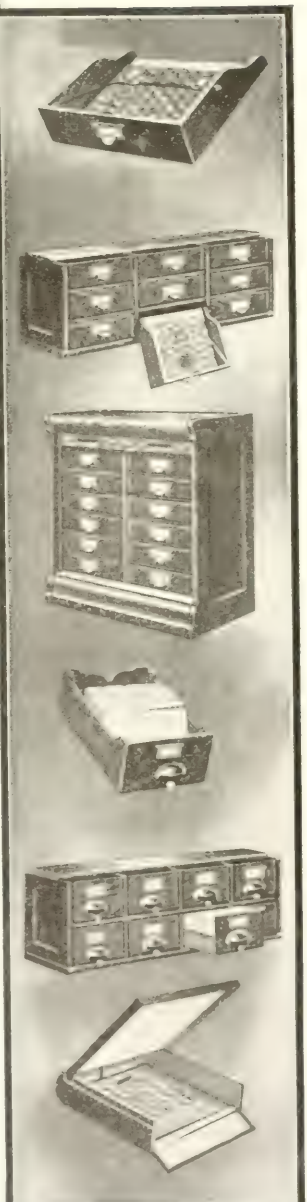
Telephone Talks Aloud

A TELEPHONE that sounds the words aloud so that all in the room may hear has been invented by M. Ducrete, a Paris engineer. When the transmitter is spoken into in an ordinary tone, the words can be plainly heard at the receiver end by one standing fifteen or twenty feet from the instrument. On the other hand, it is said, if a person takes a position close to the instrument, the slightest noise, like the ticking of a watch, can be distinctly heard.









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No. V-805. describes our complete line of filing cabinets including nearly fifty different patterns in both sectional unit and solid construction.

No. V-905. describes the various supplies which we also manufacture for these cabinets including card index cards, guides, vertical file folders, indexes, transfer cases, etc.

These two catalogues are fully as comprehensive as any and more valuable than most text books on the subject of modern office equipment. Copies mailed free on request together with list of authorized agents. Where not represented we ship filing cabinets on approval, freight paid.

The Globe-Wernicke Co.

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BRANCH STORES:—New York, Boston, Chicago.

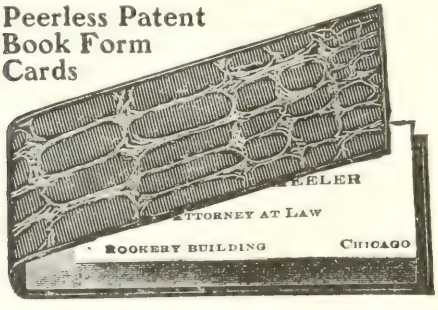
The Man Behind

that door is the one you want to see. Your personality is going to count only **after** you have gained admittance, but until then your card must speak for you.

¶ Why not use an engraved card that will appeal to the most disinterested, —a card, the neatness and correctness of which will attract the most fastidious tastes?

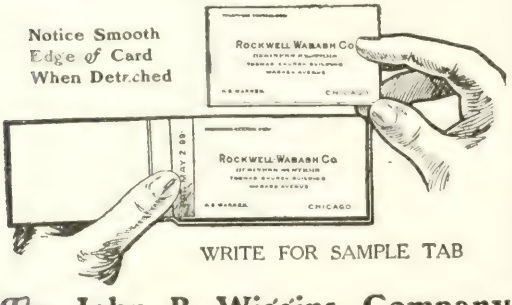
¶ You save 50% of your cards by using our Peerless Patented Book Form. Being bound together with a tissue over each card, they can not become soiled or marred in any way, and when card is detached, it is clean and perfect in every respect—all edges smooth.

Peerless Patent Book Form Cards



¶ If you use our Book Form Card, you will find there is more advertising in a bit of cardboard correctly gotten up, than in other things that cost more money.

Notice Smooth Edge of Card When Detached



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Sole Manufacturers

Peerless Patent Book Form Cards
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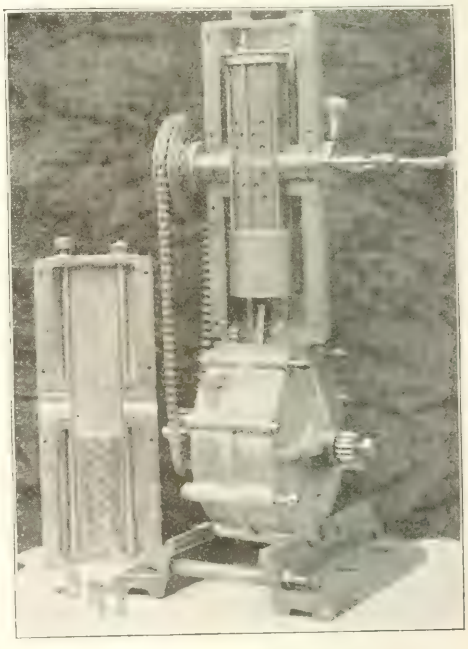
159-161 Wabash Avenue **CHICAGO**

SCIENCE AND INVENTION—(Continued)

Auto and Airship Engine

AN automobile and airship engine remarkably powerful in proportion to its weight, has resulted from a reconstruction of the old compression engine, introduced by Dr. Otto more than a score of years ago. It is known as the "Tygard." Heretofore all attempts to get more power strokes from the four-cycle motor have only resulted in multiplying the number of motor cylinders and further complicating the already too complex device. In the Tygard, the inventor has produced a new and unique arrangement of the old and well-tried parts of the engine structure—the piston, cylinder, valve, and power wheel and shaft—whereby this formidable handicap has been entirely removed and the gas engine rendered double-acting. This unique engine reverses all previous methods of construction and action, for the piston is stationary, being firmly bolted to the frame by means of lugs or trunnions extending out from its sides. In a report on a test of this engine, S. J. Beach,



LIGHT ENGINE FOR AUTOMOBILES AND AIRSHIPS.

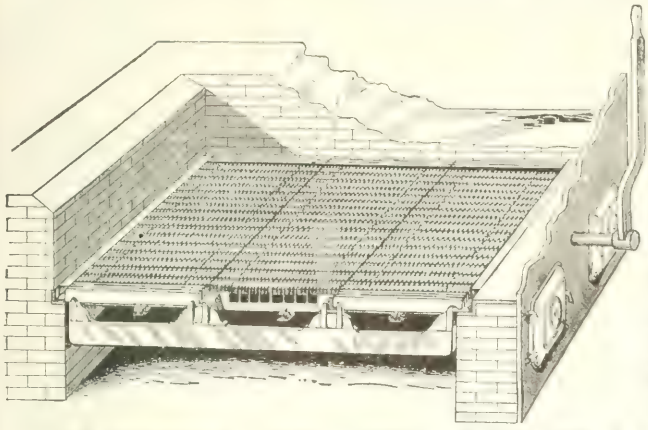
a contributor to the *Scientific American*, says:

SLACK AND SCREENINGS

are as good as high-priced coal if you use the

MARTIN ANTI-FRICTION ROCKING GRATE

THE Grate Bars run lengthwise of the furnace, are only 1½ inches wide (including teeth) and cannot be left in a position to catch the scraper when cleaning, or to project up into the fuel. No long fingers to be burned off. The fireman cannot leave any part sticking up into the fire. The spaces between bars always remain the same whether shaking or at rest, it being impossible to drop clinkers between bars and clog the grate. The heavy part of the Grate Bar is 5½ inches below the fire line, with free circulation of air through grates, and they never become hot enough to warp. Any engineer can set it in place, no cutting or changing of fire-box being necessary. Can burn any kind of coal, but is especially adapted for the slack and screenings of soft coal. The only ANTI-FRICTION grate made that cannot pinch, warp or clog, or whose openings can be changed to suit fine or coarse fuel. Send for catalogue telling all about Martin Grates.



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Rockford City Water Works,	Rockford, Ill.
Danville Water Works,	Danville, Ill.
American Radiator Co.,	Litchfield, Ill.
Oshkosh Elec. Lt. & P. Co.,	Oshkosh, Wis.
Kenosha Gas & Elec. Co.,	Kenosha, Wis.
Dodge Mfg. Co.,	Mishawaka, Ind.
Kokomo Steel & Wire Co.,	Kokomo, Ind.
Hazar Straw Bd. & Paper Co.,	Centerville, O.
H. B. Camp Co.,	Greeneville, O.
Athens Brick Co.,	Athens, O.
Iowa State College,	Ames, Ia.
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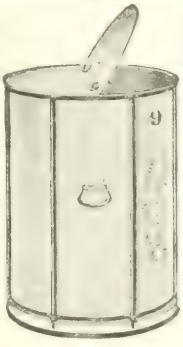
THE MORRIS ENGINEERS' WASTE CAN

WITH SELF-CLOSING COVER

¶ Is the only can on the market that is absolutely indestructible.

¶ Frame made of Steel Pipe with Angle Iron on top and bottom.

¶ Air space between bottom and floor.



¶ Hot ashes will not burn out the bottom and air space prevents burning floors.

¶ Bottom Elastic—preventing breaking.

¶ The Can will outlast five of any other.

This Can meets all requirements of the Board of Fire Underwriters

MADE EXTRA HEAVY

REGULAR SIZES:

No. 9.	17 x 25 inches.	Each - - - -	$5.50
No. 7.	15 x 25 "	" - - - -	5.00

Special Disc. to the trade. Special Cans Made to Order

These cans are also made up without spring lid for ordinary ashes

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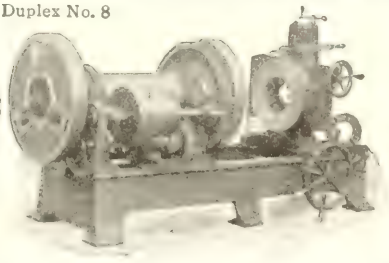

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designed to thread and cut off merchant pipe from 2½" to 8" inclusive. Nine sets of dies included. Equipped with special flange grippers for making up flanges and flanged fittings. Automatic oil pump makes it independent of others in operation. Die head has Peerless adjusting mechanism exceedingly simple and absolutely accurate.

Write for information about "the machine that lasts"

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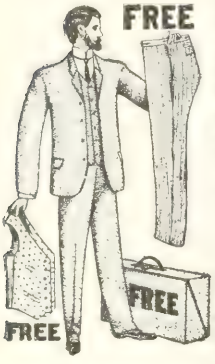
Take Your Pants Off

We Will Make You a $5.00 Pair Free.



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Write for our samples at once—we will accept your first order without **ONE CENT DEPOSIT,** you pay for suit only after thorough examination and without obligation to accept unless a perfect fit and just as claimed and equal **TO ANY $25.00 SUIT. A pair of fine all-wool stylish $5.00 pants, also a fancy dress vest, also a beautiful leather handled patent suit case all FREE with every suit.**

On request will send free samples of cloth for suit, extra pants and free vest, also illustration of patent suit case, fashion plate, measurement blanks, tape and full instructions. **We dress you in style for every day, Sunday and party day, all for only $10.**

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SCIENCE AND INVENTION—(Continued)

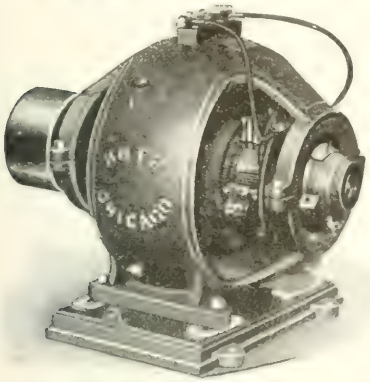
"The single valve which is connected to the gasoline vapor supply and the exhaust outlet, controls the entrance of the ignitable mixture to the engine during its suction stroke; brings the spark plug cavity into communication with the charge at the end of the compression stroke; and, at the completion of the expansion or work stroke, opens a communication with the atmosphere, while the exhaust products are being expelled by the movement of the cylinder. While this action is occurring in one combustion space, a precisely similar cycle of operations is being produced in the other combustion space. Thus, by means of a single cylinder, a single piston, a single power shaft and wheel, a single valve, and a single spark plug, a four-cycle action is produced in both ends of the cylinder alternately, producing the work of two engines from a single engine structure. As this valve-actuating mechanism is from its nature noiseless, it apparently justifies its inventor in claiming it to be the lightest and simplest and most noiseless four-cycle gasoline engine yet produced."

London Tests Pneumatic Tubes

IN an effort to introduce pneumatic tubes in London, a promoting company has set up a model plant in that city to show Englishmen how the system is worked in America. At a public exhibition given a few days ago, the operators dispatched through 800 feet of 8-inch pneumatic tubes, such varied matter as a complete suit of clothes, an egg, a live bird, and a bottle of wine. The promoters claim for this tube system, that it can carry in one day the whole quantity of mail matter dispatched by London, Paris, Berlin, and Vienna tubes in a year. It is the opinion of experts that London needs a twelve-inch tube system, the carriers of which will take three times as much as those used in America.

When this is established it is estimated that the tubes will be able to carry 82 per cent of London's internal parcel and letter traffic in one-sixth of the time now required. The initial outlay is reckoned at $15,000,000, which is a small item in London postal estimates.

The system would promise a great reduction in the working expenses of the Parcel Post bill, which is to be promoted in parliament next session.



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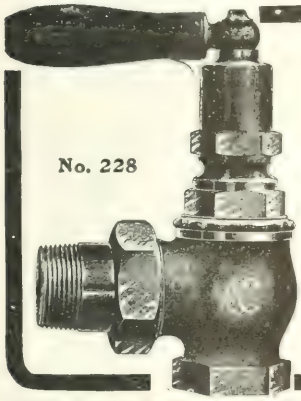

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CRANE QUICK OPENING SELF-PACKING RADIATOR VALVES

Crane Quick Opening Self-Packing Radiator Valves are the highest type of Radiator Valves on the market, combining as they do both the Quick Opening and Self-Packing features. The SELF-PACKING feature precludes any possibility of the valve leaking at the stuffing box. They open and close with a half turn of the lever, which can be operated by the foot as well as the hand. The construction of these valves is such, that when closed, the discs bear on the seats very tightly, and the valve is locked in place until released.

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Guaranteed for pressures not exceeding 75 pounds.

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Type C Engine

8 to 100 H. P.

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They are the horizontal type, 2 to 100 H. P., and are so simply and perfectly made that it requires no experience to run them, and

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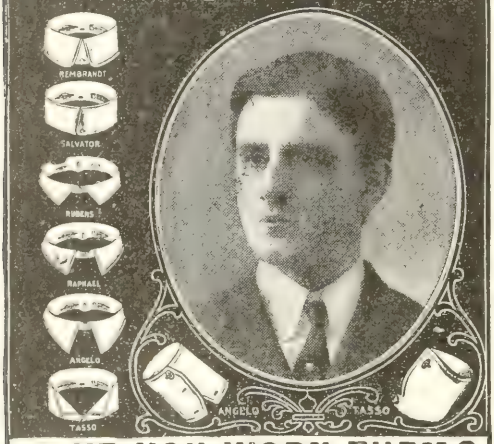
REVERSIBLE
Linene
Collars and Cuffs



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SCIENCE AND INVENTION—(Continued)

Hunter's Point Dry Dock

SAN FRANCISCO, California, while the largest Pacific seaport city between Bering Straits and Cape Horn, is very fortunate in the number and capacity of her dry docks, of which there are in all more than a dozen. The gigantic new dock at Hunter's Point water-front, is one of the largest in the world.

The main basin was literally hewed out of solid rock, the total cost of this great basin being about $700,000.

For a great many years the old dry dock, completed away back in 1868, was used for the accommodation of the larger vessels. Here, in 1896, the famous battleship *Oregon* was docked just before she went into commission.

As steam craft, in later years, were constructed on a still greater scale, the building of a giant basin to accommodate such sea-monsters as the *Siberia, Korea, Mongolia, Manchuria, Minnesota,* and other vessels of that class became an imperative necessity.

The building of the present immense dock was begun in 1901, and completed early in 1904. It is 750 feet long from the gate seat, with a width of coping of 122 feet, and at bottom 74 feet, having a depth over sill of 30 feet at high water. At the entrance on either side, are located wharf approaches 60 feet wide and 200 feet long. The new basin and the old are connected by a tunnel under the pump-pit, and the pumping plant is capable of emptying the new dock at high water in two hours, and the old dock in 45 minutes. This means a solid stream of water 8 feet in diameter, with a velocity of 500 feet per minute. The pump-pit is 35 feet in depth, and the pumping plant consists of three centrifugal double-suction pumps, each having a 38-inch discharge, with a combined capacity of 110,000 gallons per minute. These pumps are driven by three horizontal Corliss engines with 24-inch cylinders and 48-inch stroke, each having a rated capacity of 350 horse-power. The engines are connected to the pumps by means of an endless transmission rope, the engines being located on the surface, and the pumps in the pit on a level with the bottom of the dock. Steam is furnished by means of six water-tube boilers of 200 horse-power each; and there is also one 75-horse-power donkey boiler for serving drainage pump, steam capstan, etc. The water from either dock is controlled by means of large gate-valves 8 feet in diameter, hydraulically worked from the floor of the engine room.

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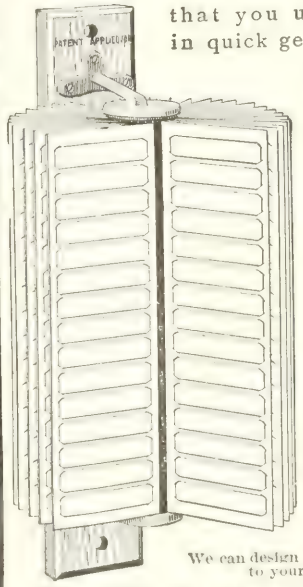

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SCIENCE AND INVENTION—(Concluded)

Antiquity of the Asiatic Bank

IT has been customary to consider that the bank originated in the twelfth century, among the Italian money changers or Jews, thanks to the creation of the letter of exchange, and to the growing custom of depositing silver in their hands. Some writers, it is true, have assigned it to Asiatic sources, claiming that it was founded by the Phœnicians and taken into the West by the Jews, though they were unable to give any valid reason for the hypothesis. But recent researches give color to the idea.

Prof. Hilprecht has recently published an article on Babylon that dates the establishment of the bank back at least two thousand five hundred years. He found, in directing the excavations of the temple of Bel at Nippur, the archives of two large banking houses, Egibi and Son, of the seventh century B. C. and Muraschu and Son, of the fifth century B. C. These banks, which did a large business, changed silver or loaned it upon the security of titles to property or upon merchandise, for the very respectable interest of 20 per cent. In a city like Babylon, where business was very active, silver and gold were, nevertheless, very rare, and the taxes necessitated by the importance of the bureaucracy and the size of the army, were payable in the precious metals. The results were that the same causes which have placed the Egyptian fellaheen in the hands of the Greek usurers, laid the foundations for the wealth of these bankers. They were a necessity to the mass of the people; and in the brick writings that have been deciphered we find the names of Persians, Jews, and Chaldeans intermingled. The accounts were most minute. Every deposit of silver or merchandise, every loan, every commercial agreement was registered on a brick, with the seal of the contracting parties, and the signature, that is the imprint of the finger-nail of the witnesses whose number varied, with the importance and length of time covered by the contract, from two to thirty. All of these bricks were numbered and classified. The bricks of the Egibi bank bear inscriptions of Semitic writing mixed with Babylonian, which is indicative of the evolution of language in Mesopotamia.

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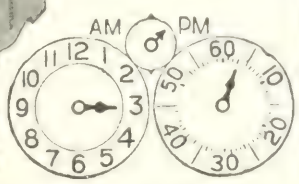

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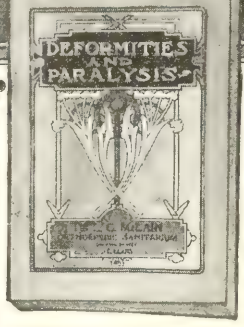

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If the question asked or the problem presented is of general interest, the solution will be printed in the columns of the magazine. If of merely personal interest, it will be forwarded by mail, provided an addressed and stamped envelope is enclosed for the purpose, when the question is sent in.

Expansion of Metals by Heat

Question: What would be the increase in area in a copper sheet if heated from 60° F. to 300° F., the original area being 54 square feet?—*A. F. W.*

COEFFICIENTS OF LINEAR EXPANSION.

Substance	Coefficient.
Aluminum	.0000123
Brass, cast	.0000096
Brass, drawn	.0000105
Brick	.0000031
Bronze	.0000099
Bismuth	.0000098
Concrete	.0000080
Copper	.0000089
Glass	.0000045
Iron, cast	.0000056
Iron, wrought	.0000065
Lead	.0000157

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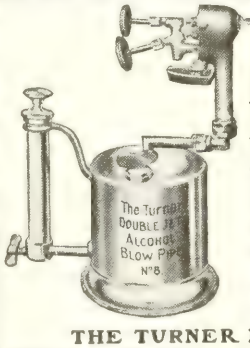

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CONSULTING DEPARTMENT—(Continued)

Mercury	.0000333
Steel, cast	.0000064
Steel, wrought	.0000069
Tin	.0000116
Zinc	.0000141

The coefficient for *area* or *surface expansion* is twice that for linear expansion; and that for *cubic* or *volume expansion* is three times that for linear expansion.

Answer: Find from the above table the coefficient of *surface expansion* of copper, .0000178. Multiply this by the number of degrees' increase in temperature, and then multiply by the number of square feet of original area; this will give $.0000178 \times 240 \times 54 = .231$ square foot or 33.3 square inches.

Clearance of Engine Cylinder

Question: How may the clearance of an engine cylinder be determined?—*E. F.*

Answer: One easy method is to disconnect the valve, and block in mid-position to cover the ports; also putty up wherever necessary to prevent leakage at either the valve or the piston. Next, place the engine on the center; and by means of the indicator pipe, fill the clearance volume with water by pailfuls, weighing each pailful before pouring in, and the amount left over in the last pailful. Then, knowing the weight of the pail, the total weight of water poured in may be found. Dividing this weight (in pounds) by 62.5, will give you the number of cubic feet in the clearance volume. Dividing this by the volume of the piston displacement will give the clearance percentage.

Pitch of Propeller

Question: What is an approximate rule for finding the pitch of a propeller?—*H. L. B.*

Answer: Find the place on the propeller blade where the slope of the face is 45°, or where it is equally inclined to the shaft and to the transverse direction. A circumference taken through this point will be equal in length to the pitch. Starting near the shaft of the propeller, the inclination to the longitudinal is small; but it increases towards the tip of the blade, passing at some point through the value 45°. Let the radius of this point be r. Then,

$$\text{Pitch} = 2\pi r = 6.2832\, r.$$

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CONSULTING DEPARTMENT—(Continued)

Angular Velocity

Question: What is angular velocity?—*B. L. C.*

Answer: It is a term used to denote the angle through which any radius of a body turns in a second; or the rate (expressed in feet per second) at which a point in the body having a radius equal to unity is moving. If the angular velocity is given in revolutions per minute, the linear velocity can be found by the formula: Linear Velocity $= 2\pi\, rn$.

A radian is equal to an arc whose length is equal to the radius of the circle. From this definition it is easy to see that there are 2π radians in one complete circle. Therefore, Radians per minute will be 2π times Revolutions per minute. But from the above we see that linear velocity $= 2\pi\, rn$, in which n is the revolutions per minute, and r is the radius. Substituting $2\pi\, n$ for "Radians per minute" in this equation, we get Linear Velocity $= r$ times Radians per minute.

Effect of Centrifugal Force

Question: Is it correct to state that centrifugal force tends to throw a revolving body away from the center?—*R. N. W.*

Answer: It is not, strictly speaking, correct, as no such force acts on the body. If the centripetal force be destroyed, the centrifugal force is destroyed at the same time, and the body goes off at a tangent instead of radially. The above form of statement is, however, a popular and convenient way to express what appears to be true, just as we say "the sun rises," to express an appearance, whereas the sun in fact does not move. Thus, the common expression, "The centrifugal force caused the fly-wheel to burst," strictly means that the arms of the wheel were not sufficiently strong to compel the rim to move in a circle, and in their effort to do it the arms were broken. But the cause of the breakage is as well understood from the common expression as from a scientific explanation of it.

Setting Corliss Valves

Question: How are Corliss valves set?—*G. L. F.*

Answer: On the back bonnet side of

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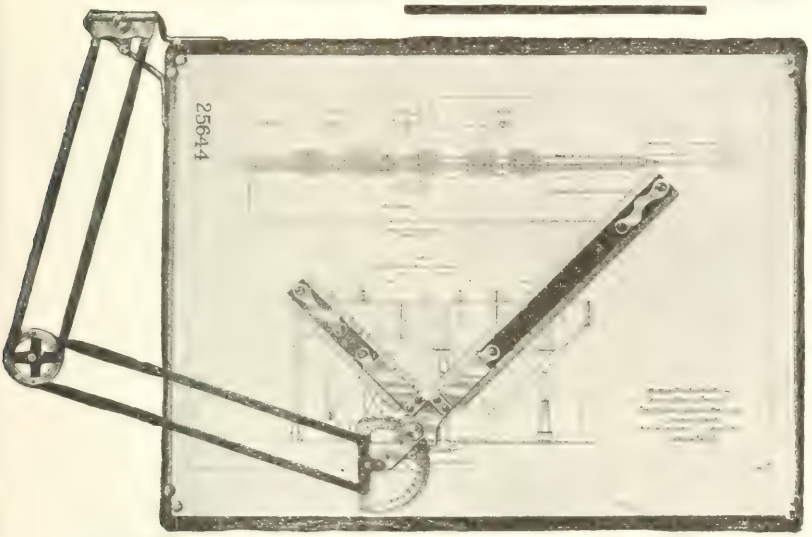

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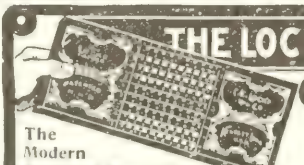

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CONSULTING DEPARTMENT—(Continued)

the cylinder and on the back end of the valves, there are radial lines which show the edges of the ports and valves. For each steam port there is a mark on the cylinder coinciding with the edge of the port which is toward the end of the cylinder; for each valve, a mark on the back end of the valve coinciding with the edge of the valve toward the end of the cylinder. The lap movement of the steam valve is toward the end of the cylinder in which the valve is located. The opening edge of the exhaust port is the edge toward the center line of the cylinder, and has its coinciding line upon the cylinder. On the exhaust valve is a mark which shows its opening edge. When the line on the back of the wrist-plate hub coincides with the line on the hub boss, the wrist-plate is in its central position.

On either side of the center line, are lines which show the extremes of travel.

To set the valves, first hold the wrist-plate on the center line. Then, by means of the rods, adjust the exhaust valves at the point of opening. The steam valves should be adjusted by the same means so that the laps will be from 1/8 to 3/8 inch, depending upon the size of the engine. For an 8-inch cylinder, the amount should be about 1/8 inch; and for a 30-inch cylinder, it should be 3/8 inch; intermediate sizes in proportion. The wrist-plate should now be connected to the eccentric by the rod and hook. With the eccentric loose on the shaft, roll it over and see if the wrist-plate moves to the extremes of travel. Make it move to these extremes by adjustment of the eccentric rod at the screw and socket.

Now that the wrist-plate is centered, place the crank so that it is on forward dead center, and roll the eccentric through an angle which is more than a quarter of a revolution in advance of the crank. This angle should be such that the lead will be from 1-32 to 1/8 of an inch, according to the speed and size. Tighten the set screw in the eccentric, and turn the engine over to crank dead center, and see if the lead is the same as for the head end; if not, adjust it by shortening or lengthening the valve rod.

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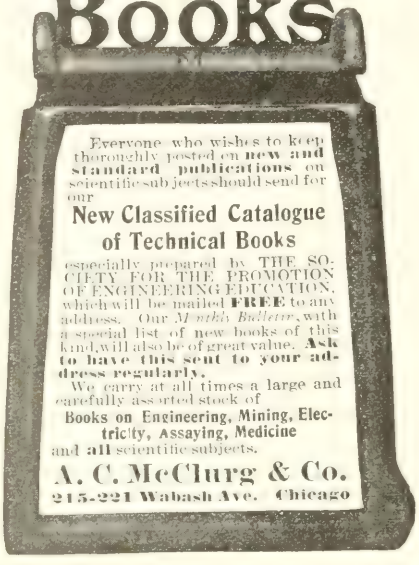
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CONSULTING DEPARTMENT—(Continued)

Electric Shock—Arc-Lamp Regulating Coil—Primary Current of Transformer

Question 1: In an arc lighting circuit supplying twenty 50-volt lamps in series, would a person get a shock of 50 volts or of 1,000 volts, if he put himself in series with the circuit in the place of an arc lamp?

Question 2: Would it make any difference if it were the lamp nearest the positive terminal of the dynamo or the one furthest from it?

Question 3: In the ordinary open-arc two-carbon lamp, is there a path for the current around the arc that is always closed so that while the lamp burns, or is giving light, there is also a very small current shunted around the arc?

Question 4: If this is so, is this path the same as the one used to shunt the lamp in case it fails to work; or are there two separate circuits around the arc?

Question 5: In step-down transformers, is there a special device for governing the current in primary circuit? If not, why does the primary current increase and decrease with the secondary current? Also, is the action the same with an ordinary induction coil?—*A. N. H.*

Answer 1: If a person were to cut himself in series with the circuit in place of an arc light, he would get a shock of practically 1,000 volts, as his resistance would be so much greater than that of the lamps in circuit that he would receive practically the full voltage of the circuit.

Answer 2: It would make no difference whatever.

Answer 3: In the shunt and differential types of arc lamp, there is always a coil of high-resistance wire shunted across the arc, for regulating purposes.

Answer 4: When arc lamps are connected in parallel, there is no need of any device for short-circuiting them when they burn out. In the series, however, there must be such a device, which consists of a short across the lamp in case the circuit opens through it. This is an automatic device which shunts the lamp with a circuit of practically zero resistance. This device has no connection whatever with the shunt winding for the regulating device.

Answer 5: There is no special device for governing the primary current of a transformer, as this piece of apparatus is automatically self-regulating. When

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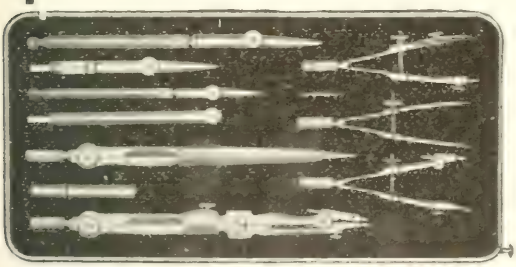

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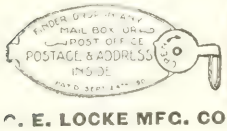

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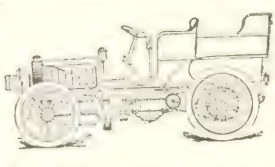

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CONSULTING DEPARTMENT—(Concluded)

the secondary circuit is open, the primary of the transformer acts as a choking coil, and the current is cut down to a very small value, namely, only that required to supply the magnetizing current and the iron losses of the transformer. When, however, the secondary current increases, it sets up a magnetic field, which reacts on that set up by the primary current in such a manner as to decrease the self-induction and allow a greater current to flow in the primary, so that the two currents increase and decrease together.

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Answer: You evidently have a 3-wire system with 100 volts between the outside wires, and 50 volts between each outside wire and the neutral. The only way, then, for you to get 50 volts is to connect from one of the outside wires to the neutral; and it makes no difference which of the outside wires you choose. If you have more than one piece of apparatus to be connected, it would of course balance your system by putting half of your translating devices on one side of the neutral, and half on the other.

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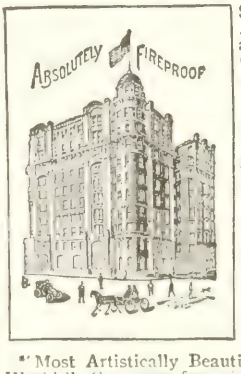

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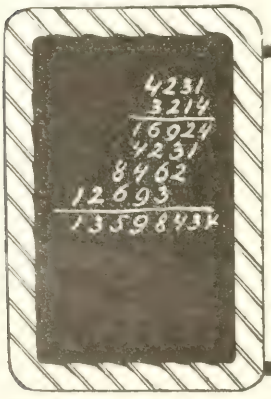

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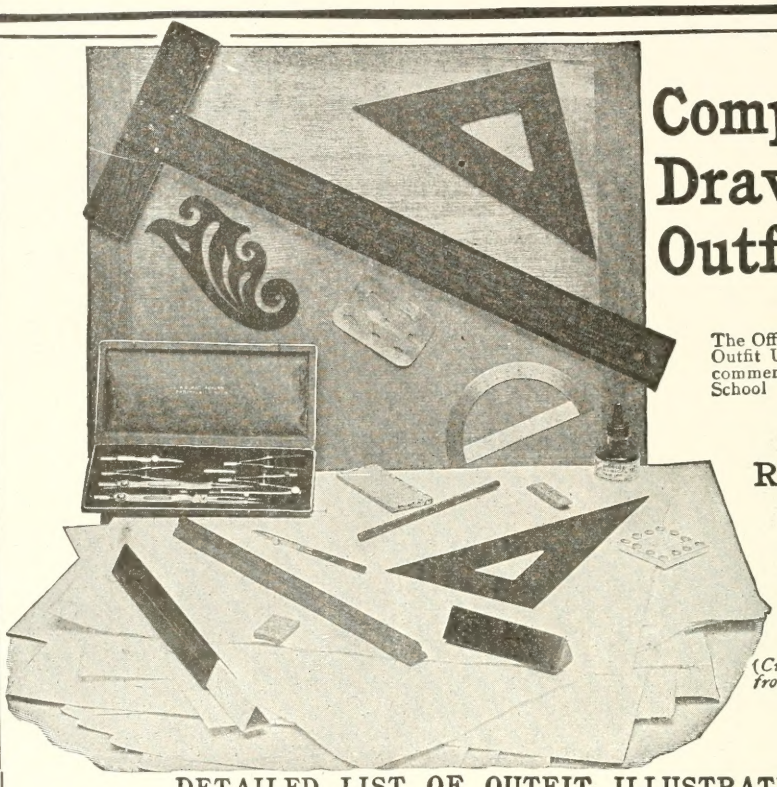

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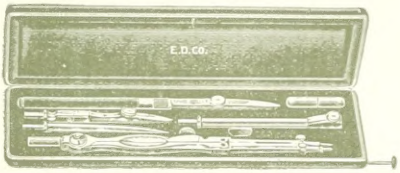

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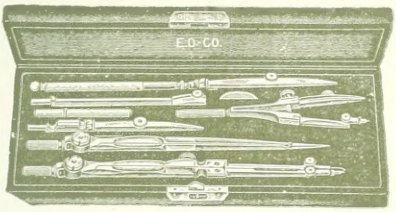

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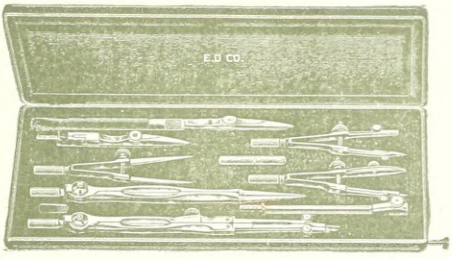

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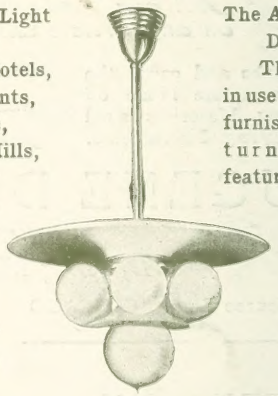

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